THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL.

VOL. 35. Thursday, March 10, 1927. No. 551.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum
Foreign and Colonial, 17s. 6d. per annum,
All Subscriptions are payable in advance.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
49, WELLINGTON STREET, LONDON, W.C.2.

Telephone: Gerrard 3951 (4 lines).
Telegraphic Address: "Zacatecas, Rand, London."

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Forthcoming Events.

MARCH 12.

Swansea Technical College Metallurgical Society:—General meeting at Swansea. "Metals and Oxygen," Paper by Dr. F. Johnson.

MARCH 15.

Sheffield Metallurgical Association:—Ordinary meeting at Sheffield. "The Burning of Coke," Paper by R. Wigginton.

Institute of British Foundrymen.

MARCH 12.

Newcastle-on-Tyne Branch (Junior Section):—Lecture on "Machine Moulding," by W. J. Molineux.

MARCH 15.

Scottish Branch:—Ordinary meeting at Glasgow. "Fractures and Analysis," Paper by P. A. Abernethy.

Lancashire Branch (Burnley Section):—Ordinary meeting at Burnley. "The Mixing of Cast Iron: with special reference to Carbon, Silicon, Phosphorus, Manganese and Sulphur," Paper by A. Buck.

MARCH 18.

Middlesbrough Branch:—Ordinary meeting at Middlesbrough. "Advantages of Foundry Control," Paper by H. J. Young, F.I.C.

Sheffield Branch:—Ordinary meeting at Sheffield. "Continental Steel Practice," Paper by V. C. Faulkner (President).

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Non-Ferrous Foundry Melting Costs.

Mr. D. F. Campbell's Paper on the electric furnace in the non-ferrous foundry is particularly illuminating, and should be studied by all our readers. Usually when electric melting is mentioned to the non-ferrous foundry owner, he exhibits what Sir Alfred Mond has aptly designated as a "No" complex. We do not insist that the time has yet arrived for every small foundry to install an electric melting furnace, but we do feel that they should be in possession of data which would show what their present system of melting is costing, what the metallic losses amount to, and especially the cost of upkeep and depreciation. In the Paper referred to Mr. Campbell has unfortunately given no idea of the allowances that should be made for depreciation in the case of both crucible and electric furnaces. Conditions are such in the non-ferrous industries that melting costs are overshadowed by metal costs, and the clever buying of raw materials can often give an almost overwhelming advantage to the foundry so placed. An advantage of which the crucible can never be robbed is its elasticity and convenience. Its method of operation can be easily adapted to suit varying conditions of output, of size of the castings, and in their composition. We feel it would have been of interest for the author to have included the comparative costs as against a reverberatory furnace, as this type is making considerable headway in the industry. Mr. Campbell places the "running" melting costs using a modern electric furnace and a normal crucible installation at 23s. 10d. and 36s. respectively, and using a similar basis, we calculate that a modern reverberatory furnace would be about 18s. per ton, using, say, a 6-cwt. capacity unit. These figures, however, are all far from expressing the relative utility to any individual foundry, where the varying conditions may demand low zinc losses, small quantities of alloys of varying composition, space considerations, local cost of fuel, etc. Again, in speaking of the crucible it should be remembered that many modifications of this type of plant exist. For instance, some are of the tilting variety, some are oil-fired, whilst some of the stationary ones—though rarely in non-ferrous practice—may be producer-gas fired. The pointing out that electric melting can yield a saving of 12s. per ton over the crucible process should induce foundrymen to make comparisons with their own practice, and in doing so it should be borne in mind that the larger the number of users of electric furnaces, the more favourable are the current-generation conditions existing at the power station. The economies effected should be shared by the consumer, and undoubtedly if a group of founders were co-operatively to approach a power company, they could, by agreeing amongst themselves to equalise the load on the mains, secure very advantageous terms. It would be necessary to ascertain whether the cost of a periodic week of night-shift work only would be balanced by the cheaper cost of current. There is one important factor not to be lost sight of, and that is the continued operation of an electric furnace may bring to light the existence of an alloy which can only be satisfactorily so manufactured by that process, as has been the case with stainless steel in ferrous metallurgy, and in one direction we rather think this has already been achieved.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Foundry Costing.

To the Editor of The Foundry Trade Journal.

Sir,—The leading articles in your issues of February 24 and March 3 raise a matter of the utmost importance and interest, which the writer has frequently discussed with other founders. He ventures the opinion that in the current issue you have under-estimated the factors which render inevitable a distressingly great disparity of prices in the foundry industry.

Leaving aside the many minor causes, such as differences in weight estimations, errors of estimating due to lack of knowledge of the design and condition of customers' patterns, differences of equipment and moulding practices as between one foundry and another, the fundamental factor is undoubtedly the complete lack of uniformity in methods of estimation. Some founders admittedly guess prices outright.

Others make a fairly honest attempt to calculate the average self-cost of all costings falling within various weight ranges, and then quote prices within these ranges, irrespective of the individual difference between one casting and another.

Some, again, go to the trouble and expense of working out a specific estimate of the cost of labour, material, and charges on every inquiry obtained.

Even among founders in this last category the resultant price will depend largely upon whether their standing charges be allocated *pro rata* total wages, *pro rata* direct wages, *pro rata* weight, or *pro rata* weight plus wages, all of which systems are prevalent.

The suggestion that a large number of founders should accept and abide by a uniform system of costing constitutes an ideal which is unlikely to be realised, since a costing system must be designed to suit the circumstances of each individual plant and with an eye to any particular line for the exploitation of which a foundry may have laid itself out especially. It should be immaterial what method of costing be pursued, especially as regards the allocation of standing charges, so long as the system results in the complete absorption over the year's output of the whole of the standing charges accured.

It is suggested that, as the narrowing by artificial means of the price disparity in the industry would at the best be extremely difficult of achievement, the most promising line of advance would be the inauguration of a campaign within the industry to demonstrate to all founders the supreme importance in their own interest and in that of the industry as a whole of estimating with some considerable accuracy on whatever basis best suits each firm, the actual self-cost of production *of each job* coupled with a firm rule that in no case will a price below cost be quoted.

The buyer will always be free to exploit the inevitable difference between the costing methods and the productive facilities of various competing tenderers, and may be relied upon to continue to do so. There is, however, no good reason why any founder should extend to any buyer the grotesque advantage of purchasing from him at a figure well below cost.—Yours, etc.,

R. F. Abel.

Kryn and Lahy Metal Works, Limited,
Letchworth. March 5.

High Frequency Electric Melting of Steel.

The Electric Furnace Company, Limited, of 17, Victoria Street, Westminster, have received further orders for high-frequency electric furnaces for the manufacture of high-grade tool steel from W. Jessop & Company, Limited, of Sheffield, and J. Holtzer & Company, of Unieux, France. Each installation will be capable of melting about four tons of alloy steel per day. The advantage of this new method of melting steel is thus gaining recognition among both British and Continental steel makers of high repute.

Catalogues Received.

Special Alloys.—The Telegraph Construction and Maintenance Company, Limited, of 38, Old Broad Street, London, E.C.2, have sent us two catalogues, one dealing with magnetic alloys and the second a nickel chrome high-temperature electrical resistance alloy.

The former describes by means of 24 graphs two alloys—Mumetal and Rhometal—which are marketed in the form of wire strip, sheets, bars, rods and castings. The range of electrical resistance of mumetal is between 22 and 70 microhms per cub. centimetre, the actual requirements being met by changes in composition and heat treatment.

The nickel chrome alloy dealt with in the second catalogue is called Pyromic, which has an electric resistance of not less than 100 microhms per cub. centimetre. It, too, is supplied in wire of all gauges in strip or tape, and in rods and bars. We strongly advise our readers to familiarise themselves with these developments, as they will affect the question of industrial heating—such as core-drying and similar propositions—very seriously, owing to cleanliness and ease of regulation in the near future.

A picture of the firm's foundry at Bilston, Staffs., is given as a frontispiece. Apparently it contains 40 electric-resistance furnaces of the latest type, and is quite the neatest melting shop we have ever seen photographed.

Moulding Machines.—The Denbigh Engineering Company, Limited, of Horseley Heath, Tipton, Staffs., have produced a new 24-page catalogue illustrating and describing a range of moulding machines, mainly of the hand jolt-ram type—a machine which is quite unique in both conception and design. The descriptive matter is clear and well set out, the pictures being particularly illuminating. Each phase of working is separately dealt with, from the action of the jar to the stripping of the mould. Then each type of machine is separately dealt with, thus making the catalogue a real manual for the operator. The machine is too well known to need description here, but to appreciate all the finer points we strongly advise all our readers to procure a copy, for we understand it is available to the trade on application.

Foundry Query.

Acid-Resisting Iron.

We wonder if you could oblige us with information regarding a good analysis for acid-resisting cast iron?

We have been given an analysis as follows, but before using it we think it would be better to have some further advice on the subject, as the parts to be made will be very important: 90 No. 4 hematite, 1.5 silicon, and 10 per cent. mottled foundry iron.

The castings will be required to withstand pump conditions, and will be pumping perodine and weak sulphuric acid. We understand that the mixture required will make the resultant castings very hard, and they will be unmachinable and will have to be ground. If you can give us any further information it will be acceptable. —S. O. T.

Notes from France.

The Association Technique de Fonderie has decided to increase the annual subscription to 100 francs.

In future the French foundry magazine *La Revue de Fonderie Moderne* is to appear fortnightly.

Mr. W. M. Corse, the well-known American metallurgist, has been appointed director of a newly-formed research organisation to be known as the American Bronze Manufacturers' Institute.

The Bethlehem Steel Company has recently cast an ingot mould weighing 170 tons.

Electric Furnaces in Non-Ferrous Metallurgy.*

By Donald F. Campbell, M.A., A.R.S.M.

The progressive decrease in the price of electric power and the rapid improvement in the design of electric equipment are increasing the scope of electro-metallurgy.

It is proposed to give a short survey of the metallurgical field in which electrical heating can be economically applied at the present time, and to indicate the lines of possible expansion.

Single furnaces of 4,000 to 10,000 kw. are now engaged in smelting pig-iron and in the manufacture of carbide, while probably about half a million kw. of furnace capacity are engaged in melting metals, to which must be added a million or more kw. of generating machinery used for making aluminium and smelting ferro-alloys. This indicates the importance of this industry as a consumer of power, but this Paper is intended to deal with the smaller units, which have been applied to the melting and treatment of alloys of copper, nickel, zinc, and the precious metals.

There are a few general principles which seem necessary in the design of efficient electro-metallurgical plant. It is essential that equipment should firstly satisfy the requirements of the metallurgist, and that the electrical engineer should meet his demands. The electrical engineer should then be given a free hand and allowed to purchase only the very best equipment. No modification should be made in the design without his consent, as the construction of efficient furnaces requires a very highly specialised theoretical knowledge and long experience of this special branch of electrical engineering. Numerous failures in electric furnaces are due to metallurgists interfering in electrical equipment, or electrical engineers designing impractical metallurgical appliances, while purchasing departments have not infrequently caused trouble by buying inferior equipment for the arduous service inseparable from metallurgical work. For almost every group of alloys an electric furnace of special design is required, and for any particular metal, the type of furnace to be selected may depend on the hours of work.

Electricity was first applied in the non-ferrous trades by using arc furnaces, a development resulting from the wide use of arc furnaces of the Héroult or Stassano type in the steel trade. The furnace of each of these pioneers was modified by numerous designers of equipment, but they incorporate the same fundamental principles.

For non-ferrous metals a number of arc furnaces were built, such as the Detroit rotating arc furnace, the Brown-Boveri and the Rennerfelt arc furnace. The intense heat of the arc, which is so favourable for steel melting, seemed unnecessary for the comparatively low temperatures required for brass melting, and, consequently, indirect heating by reflecting the heat of the roof was developed by Bailey.

This method of heating is necessarily inefficient as compared with the generation of heat units within the metal itself, and consequently the principle of induction heating gives lower power consumption for continuous work than this or any other system of melting brass.

Wyatt and the Ajax Metal Company were responsible for the development of the first successful induction furnace for brass melting. This furnace, however, has certain limitations as regards the metals that can be melted, and consequently the Bailey furnace, with its simple form of hearth and the high-frequency furnace, has found application in certain cases in the non-ferrous trades.

The Ajax-Wyatt furnace is now the standard melting equipment for supplying brass mills. It consists of a cylindrical steel vessel lined with brickwork or rammed refractory material, below which a transformer is suspended, the secondary of which is a vertical V-shaped channel arranged so that it passes round the primary winding and iron of the transformer.

*A Paper read before the Spring meeting of the Institute of Metals.

Heat is generated in this secondary, and the metal is well circulated by electrical forces, so that hot metal is constantly forced out of the secondary, and cooler metal takes its place. This mixing effect is due to three forces—namely, convection currents, electric motor effect, and "pinch" effect.

The electrical design of these furnaces requires care, but metallurgically they work with extraordinarily little trouble if the bottoms are properly made and dried. The cost of refractories may be as low as 1s. per ton melted, or considerably higher if accidents happen, such as failure of power supply, slovenly preparation of the bottom, or exceptional carelessness on the part of workmen.

The life of the linings varies from two or three months to two or three years, and as the cost of labour and materials for ramming the bottom only costs from £30 to £40 it is clear that this is not a very serious item on an output of 600 to 1,200 tons per lining.

These furnaces are usually run continuously at 60 kw., producing 600 lbs. of brass every 60 to 70

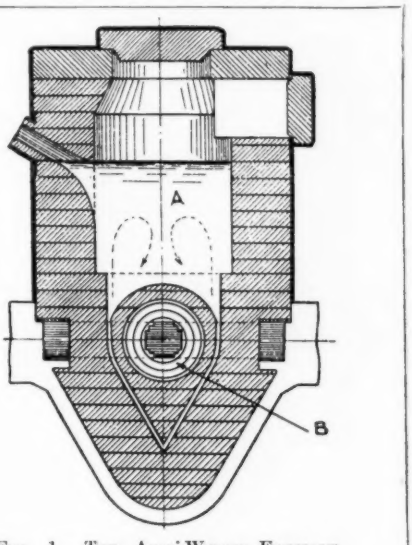

FIG. 1.—THE AJAX-WYATT FURNACE.

minutes, and during periods of idleness the furnace is kept warm with a current consumption of about eight units an hour. This stand-by current consumption must be added to that used usefully during the melting period, and consequently the average monthly power consumption per ton melted will vary considerably according to the proportion of working time to idle hours.

Some operators prefer to empty their furnaces during holidays, but there is some risk of cracking the refractory lining or failing to make connection in the secondary channel when restarting, so that furnaces are kept continuously hot in most works.

The construction of the furnace is seen in Fig. 1, and Fig. 2 shows a typical installation with ingot moulds on a turntable.

The power consumption when melting 60 : 40 brass with this furnace should not exceed 220 units per ton, to which must be added the stand-by current consumed during idle hours.

Although the efficiency resulting from the generation of the heat within the metal itself is remarkable, its limitations are serious, as suitable refractory materials have not yet been found to produce linings for metals of high melting point, such as nickel alloys, steel, etc. Continuous research is going on at the present time to improve linings and widen the field of application of this method of melting.

Another consideration is the necessity of leaving sufficient metal in the furnace between heats to fill the secondary channel. This may be objectionable, if it is desired to change the mixture frequently, though slight changes in the composition of brasses, etc., present no difficulties. A considerable economy in the cost of making brass in this furnace is due to the accuracy of composition attainable, so that the usual margin of copper in excess of the specification can be reduced.

The following figures show typical performances of Ajax-Wyatt furnaces in Birmingham, working under favourable conditions:—

Actual day's run in 75 kv.a. Furnace on 61 : 39 *Brass, Birmingham, April,* 1926.

Time.		Total time.	Units	Metal	Lb.	Units
Charged.	Poured.	Mins.	Used.	charged lb.	per unit.	per ton.
6.30	7.30	60	68	610	8.98	250
7.30	8.50	60	58	610	10.50	214
8.30	9.15	45	58	610	10.50	214
9.15	9.59	44	48	610	12.70	176
9.59	10.54	55	56	610	10.88	206
10.54	11.44	50	52	610	11.72	191
11.44	12.53	49	51	590	11.56	194
11.33	1.26	53	58	590	10.15	220
1.26	2.10	44	53	590	11.22	199
2.10	3.5	55	46	590	12.80	175
3.5	3.57	52	55	590	10.70	210
3.57	4.47	50	50	590	11.78	190
4.47	4.45	58	59	590	9.67	232
		11hrs 15m.	712	7,790	10.92	206

The average cost of fuelling 1 ton of 60 : 40 brass for extrusion billets in a 600 lb. Ajax-Wyatt furnace is as follows:—

	s.	d.
Power, 224 kw. hrs. at 0.75d.	14	0
Lining and repairs	1	6
Labour, 1 man per shift at £5, making 12 tons per week per shift	8	4
	23	10

N.B.—From this sum should be deducted the amount saved by reduction in furnace metal losses when comparing with other melting furnaces, say 10s.

Pit fire costs at different works at Birmingham vary considerably, but the following are, it is believed, a fair average cost per ton in works manufacturing 60 : 40 brass for extrusion billets under economic conditions:—

	s.	d.
Coke	8	0
Crucibles	4	6
Repairs	1	0
Labour	22	6
	36	0

There is in nearly all cases a saving of at least 1 per cent. in the loss of zinc, though methods of calculating losses are so varied that this statement may lead to some discussion. There is no doubt that in many works the saving is considerably higher than this figure.

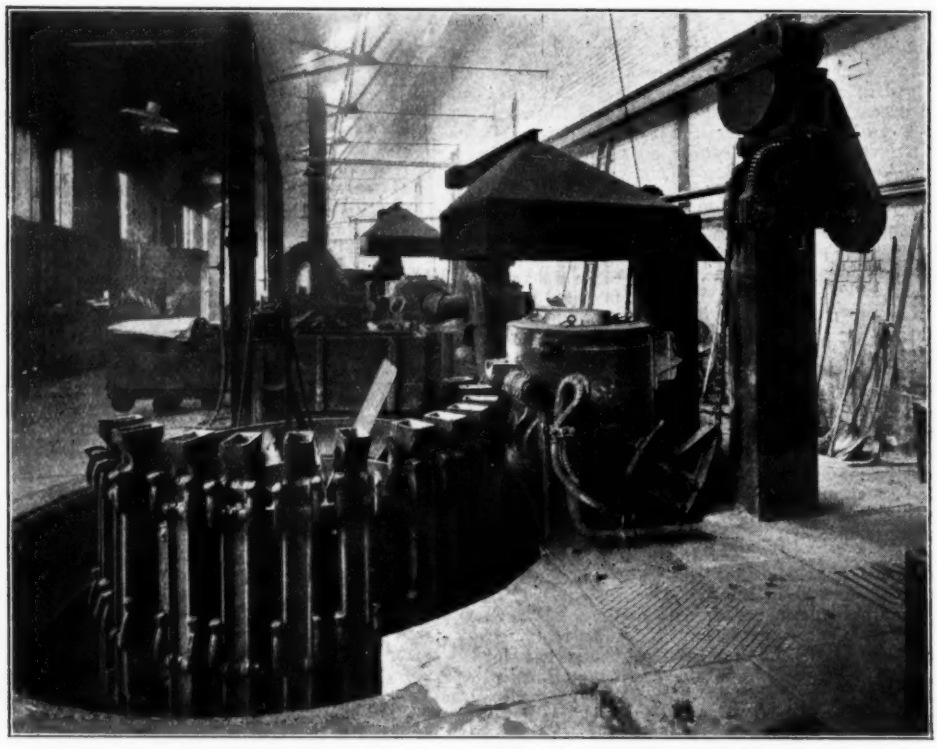

Fig. 2.—Ajax-Wyatt Installation with Ingot Moulds on a Turntable.

A saving of 1 per cent. with spelter at £35 per ton is equal to 7s. per ton of brass.

If the savings due to no expense or space being required for storage of coke and handling of ashes, and the improvement of working conditions and ease of handling be added, it will be seen that a reduction of working costs of at least £1 per ton is obtained, which provides the necessary funds for the amortisation of the capital expenditure for the furnaces in one to two years.

The Ajax-Northrup furnace is the newest form of melting equipment, and possesses many remarkable features.

The metal is heated by induction in a high-frequency field, wherein there is no need of iron, nor of a secondary of the type used in normal frequency induction furnaces. This is a great advantage metallurgically, as the furnace itself is of curiously simple construction, consisting only of a crucible, round which a spiral inductor coil is wound, with the narrow intermediate space filled with zirconite or some other heat insulator.

The construction is seen in Fig. 3, which shows the charge, crucible, zirconite powder for heat-insulation, the mica or silica sleeve, the high-frequency inductor coil and furnace body, which may be of wood. The distance between the coil, which is usually at a temperature of about 60 deg. C., and the molten metal, which may be at 1,700 deg. to 1,800 deg C., is only 0.75 in. in a platinum furnace or 2.5 in. in a 6-cwt. furnace. The temperature gradient is accordingly very steep and the outside of the crucible is only just red when the metal is molten; hence, it is obvious that the wear of crucibles on the outside is almost negligible. Furthermore, the crucible is mechanic-

ally supported all over its outer surface by well-packed powdered zirconite, which eliminates any tendency for the crucible to break owing to the weight of the charge.

Recent results on a large number of consecutive heats of different alloys made in Ajax-Northrup furnaces holding about 600 lbs. are as follows:—

6-cwt. charges of nickel-silver containing about 15 per cent. of nickel were melted in an average time of 1 hr., the average production being 6.7 lbs. per kw.-hr., or just under 350 units per ton.

4-cwt. charges of cupro-nickel were melted in an average time of 55 minutes, the average production being 5.0 lbs. per kw.-hr., or 448 units per ton.

The average life of crucibles in a large number of heats of cupro-nickel and nickel-silver was 58, which was increased to 95 by patching, but it was found to be doubtful whether the delay caused by patching was justified by reduced costs. It requires about 4 hrs. for the crucible to cool before patching can be begun and 6 hrs. for subsequent drying. The wear on crucibles is normally about 0.75 in. deep after 60 heats of nickel-silver.

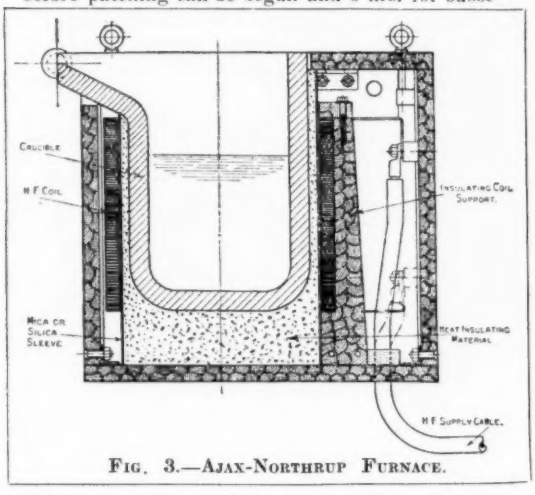

Fig. 3.—Ajax-Northrup Furnace.

The conditions of melting in Ajax-Wyatt and Northrup furnaces of normal design are not those suitable for melting aluminium and its alloys, which should be melted in tranquillity.

Experiments are now being made to evolve equipment giving the requisite conditions, but the final form of the most suitable furnace is not yet determined, as all experiments of this type must be made over a long period and on a substantial scale before electric melting can be confidently recommended, and cost of operation and quality of product established.

Some results obtained in the United States when melting silver may also be of interest:—

Total number of heats in one crucible	129
Total lb. (avoirdupois) melted	118,950
Lb. melted per kw.-hr.	10.9
Average weight per charge	922.5 lbs.
Power input	100 kw.

Improvements in detail are being made which are expected to increase the output to well over 11 lbs. per kw.-hr.

High-frequency melting is technically applicable to almost any metal-melting work, though its use is limited at present to cases where economic conditions are favourable. Two such cases may be mentioned. In one works twelve furnaces, each of 600-lb. capacity, have been in regular use for a considerable time, melting copper scrap and nickel alloys. Two batteries, each of six furnaces, are in this case supplied with 100 kw. each from two 600-kw. machines generating 480 cycle current at 900 volts. The produce of these furnaces is remarkable for its homogeneity, and the wear of crucibles is only a fraction of that in coke furnaces, because they are cooled and supported by powdered insulating material on the outside. The first heat can be poured within 75 minutes of commencing work, and the absence of coke, ashes, furnace gases, and other incidental troubles makes this system of melting most advantageous for all nickel alloys.

Another interesting installation of small units was erected in Staffordshire to manufacture nickel-iron alloys of exceptional purity to be used for "loading" submarine cables. In this case, high-frequency current was produced by mercury spark gaps operated in hydrogen with batteries of condensers for power factor improvement. Forty-two such units were used and have been operated for many months, both day and night shifts, with satisfactory results. For submarine cable work the maximum carbon allowed is 0.02 per cent., and metal to this specification was regularly produced under factory conditions. These small units are also used by all the leading platinum refiners, and can melt 5—6 lbs. of this metal in about 15 minutes.

The production of other alloys and metals of equal purity opens a wide field for useful research, which may lead to the disappearance of many difficulties of subsequent manipulation, such as wire-drawing, deep-pressing, etc., while the examination of such pure metals as carbon-free nickel-chrome alloys is likely to reveal properties of great value to the electrical industry.

In many cases, metals of greater purity than those hitherto available are proving to have properties of the utmost value. All alloys of nickel can be economically melted by the process, and the metallurgical features of the process are interesting, because intense mixing gives homogeneous metal. The metal is accessible for alloying, sampling, and inspection, and any desired temperature can be obtained, maintained, and controlled.

As compared with "pit fires," this furnace has the advantage of avoiding all contamination from sulphurous fumes and other impurities. Labour costs are reduced, and skilled casters of exceptional strength are unnecessary, while absolute control of heat and complete mixing are obtained.

The space occupied by coke and ashes is no longer required, while chimney and furnace repairs are eliminated. Crucible costs are reduced to a fraction of those of pit fires. On the other hand, capital expenditure is considerable, and a skilled electrician is required for rotary machinery. For works operating by day only this furnace has great advantages, though the interest charges are naturally increased by the shorter hours of work.

It is interesting to compare the effect of stand-by losses on an Ajax-Wyatt furnace with the conditions when operating an Ajax-Northrup furnace, which has no stand-by loss during idle hours, but has a lower over-all efficiency for the conversion of energy from the electric supply mains to useful heat units. In the latter case high-frequency energy is generated by a motor generator which has an efficiency of only about 72 per cent.; the additional loss in the furnace itself reducing the over-all efficiency to about 60 per cent. against 83 per cent. for the Ajax-Wyatt furnace. If the two furnaces be worked 8 to 10 hrs. per day for 5½ days a week, it will be found that the high-frequency Northrup furnace is about equal in efficiency and possesses several marked advantages for numerous difficult metallurgical operations.

The capital expenditure per kw. installed is approximately the same for the two furnaces, and the operating cost of the Wyatt furnace is lower for continuous operations.

The extent to which electric heating can be applied to heat-treatment of metals depends largely on the relative price of electricity, coal, and gas, but although low rates are charged in some of our towns for electric heating, little is being used for heat-treatment as compared with the United States, where the price of energy in many cases is not exceptionally low. Ample capital and the general desire to reduce labour charges and standardise production have influenced American works executives to utilise electricity.

Accuracy of control, cleanliness, and thermal efficiency are the characteristics which are offset by a high price per unit of heat, and for many intricate operations the use of electricity is fully justified.

For enamelling metal and glazing pottery the rapidity and convenience of closely applied electric heat justify its use, while, in the annealing of glass and heat-treatment of metal, the accuracy of control has led to its adoption. Each application requires careful consideration, both of the technical and economical factors, but, generally

speaking, electric heating is finding progressively wide application. Furnaces for these purposes are generally heated by nickel-chrome resistors, and numerous furnaces of several hundred kw. are in use for annealing wire, stoving motor-car bodies, and similar uses.

In this country the Wild-Barfield furnaces have found wide application in tool rooms. The furnaces, when heated with a special winding, indicate the decalescent point of the steel being treated, and this enables the metallurgist to control his operation closely.

Small internally-heated furnaces for various purposes and large units of the "EFCO" type have special grooved and perforated bricks, through which spirals of nickel-chrome wire are fitted. The resistors are connected direct on the three phases of the supply system, with automatic control, whereby the temperature can be maintained within 1 per cent. of the required heat.

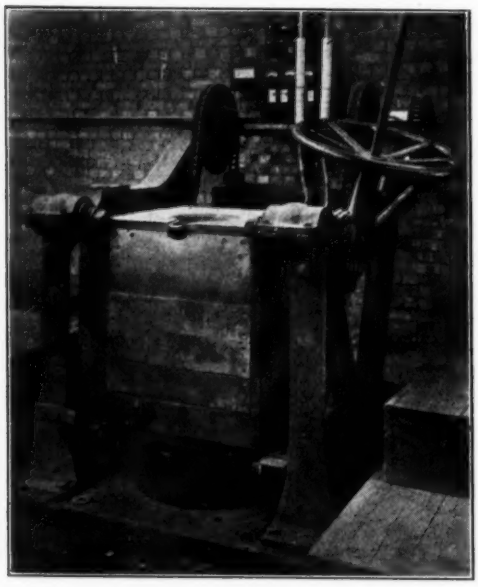

FIG. 4.—THE AJAX-NORTHRUP HIGH-FREQUENCY INDUCTION FURNACE 3- TO 6-CWT. CAPACITY.

A patented feature of this furnace is the use of a star-mesh switch, whereby the voltage can be varied in the ratio of 172 to 100, and the furnace can, consequently, be heated up more rapidly without the use of auto-transformers than when one voltage only is available.

The use of various resistance furnaces for heating is expanding rapidly, and the field of usefulness is very wide. The glazing of pottery is a typical example. In the old process this operation frequently takes eight days, and many tons of brickwork are heated to 1,200 deg. C. for each ton of pottery. The percentage of wasters is always high owing to ashes, flue gas, dust, etc. In electric furnaces the pottery may be continuously passed through a tunnel, the entire operation taking only 2 hrs., and the percentage of wasters being negligible. This is a good example of applying expensive forms of heat economically and obtaining favourable conditions, such as high yield, automatic temperature control, cleanliness, and rapidity of working.

In this Paper it has been impossible to deal with many other applications of electro-metallurgy, such as the manufacture of zinc, tin, silver, carbon bisulphide, etc., and the recovery of valuable metals from slags, in all of which electric furnaces are being used.

In the near future, several years of research and development work on the use of valves to produce extra high-frequency currents will result in new methods of heat-treatment becoming available for heating wire, tubes, and various metallic products.

Only the fringe of the field of heating by electric resistance or induction has been prospected, and every branch of metallurgy has a number of interesting problems in which electric heating will surely find its place.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Nickel and Nickel-Chromium in Cast Iron.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Mr. F. D. Corbin's most appreciative letter in your issue dated February 17, 1927, asks for further information upon several of the points raised in my article upon "Nickel and Nickel-Chromium Cast Irons now used in America," which was published in your issues dated January 20 and 27, 1927.

In view of the fact that Dr. Everest is at present engaged on a research in this Department upon the use of a nickel in cast iron, I beg to be excused from answering these questions fully at the present time.

The point I wished to make about chromium was that it increases the combined carbon. It has been observed that the total carbon may also be increased, and this is not welcomed by those whose melting is restricted to the cupola. I have seen cast iron with low total-carbon produced for special purposes in reverberatory furnaces, and grey iron is being cast in increasing quantities from electric furnaces. The only other method known to me of decreasing the total carbon is to add liquid low-carbon converter metal to the ladle or forehearth.

As regards the effect of nickel upon the graphite, I believe that, with any given content of silicon, nickel will tend to produce finer flakes of graphite. The research work now in progress will probably lead to the publication of quantitative figures for the relative greying power of nickel and silicon.

The question of machineable hardness certainly is of great importance. Probably the actual hardness which is machineable depends more upon the uniformity of the material than upon hardness measurements. The ease with which a nickel cast iron can be machined, relative to a similar cast iron without any nickel, is therefore to be explained in part by the absence of hard spots and of large hard grains. Although the matrix is frequently tough sorbite, the grains are small and relatively uniform, and hence present a more uniform resistance to the cutting tool.

As regards the possibility of a Martensite *plus* fine graphite structure for heavy friction duty, it has been shown that the microstructure of the matrix is changed from pearlite to sorbite with low additions of nickel, and Dr. Partridge reported that a specimen containing 10 per cent. nickel and 2 per cent. of manganese was extremely hard and difficult to machine, owing to the presence of Martensite. Such irons are practically unmachineable, despite the fact that they contain a considerable amount of graphite. Dr. Partridge also made a 12 per cent. Ni cast iron, which was non-magnetic owing to its remaining in the austenitic condition after cooling in the mould. These high-nickel cast irons do take on a very fine polish, and may therefore be suitable for heavy friction duty, but I believe it would be a mistake to expect them to be at all readily machineable.

Lastly, concerning the possibility of combining suitable nickel and nickel-chromium additions with Perlit iron foundry practice, I do not anticipate any great advantage in this direction, as the uniformity of the pearlite structure attained by such practice has already been achieved if the nickel addition has been made in the required proportion to a suitable iron mixture.

I should like to thank Mr. Corbin for the interesting details he gives regarding his own practice, and to add that the use of a nickel-silicon alloy, in shot or other form, does appear to be relatively novel and to offer very promising possibilities.—Yours, etc.,

T. HENRY TURNER,
Lecturer, Department of Metallurgy.

The University,
Birmingham.
February 25, 1927.

The "Revue de Fonderie," the official organ of the Belgian Foundry Technical Association, ceased publication with the December issue. It is to be amalgamated with "Fonderie Moderne," the French foundry monthly journal.

Principles of Testing.

By H. R. Pitt.

(*Continued from page* 194.)

Methods of Expressing Test Results.

The expression of test results in a manner to indicate a definite value has and always will be a matter of difficulty, involving some confusion, while there exists such a lack of uniformity in national systems of weights and measures.

In the statement of tensile strength foundrymen in this country are quite satisfied with tons per sq. in. and the conversion of figures so stated into kg. per sq. mm. is not a difficult process. The same can, however, hardly be said for the transverse test, which may be given on bars varying both in section and length. Not only does this involve elaborate calculation to reduce to a given set of dimensions, but further complications arise in that the formulæ are not, in practice, found to apply accurately from small to large dimension and *vice versa*.

Two factors are mainly brought into play here, the one being the alterations brought about, in metals generally but to a very notable degree in cast iron, in both molecular condition and in crystalline structure by casting the same metal into sections when the influence of mass and the rate of cooling act to refine or coarsen the texture according as the section is small or large.

Above and beyond this is the fact demonstrated by Bell and Adamson in their Paper contributed to the Iron and Steel Institute in 1924, which proved with some conclusiveness that the engineering formulæ for beams do not hold good for cast iron, and that conversions by calculation were not reconcilable with results obtained in practice. This fact was also brought to light in Hailstone's earlier and valuable Paper on the physical properties of cast iron read before the Iron and Steel Institute in 1914, in which he pointed out that the ratio of the 1 × 1-in. bar on 12-in. centres to the 1 × 2-in. bar on 33-in. centres was reduced to 1.153 if the bars are machined and 1.146 if tested as cast.

These discrepancies are, of course, equally noticeable in any tests upon cast iron which, for reasons which are well known, cannot be assumed to have proportional strength in accordance with the size of its section.

Figure of Merit.

A German investigator, Dr. Sachs, in regard to steel, has recently suggested that some unit expressing the general quality might be arrived at by co-relating the ascertained tensile, elongation and reduction of area. He would call this a "figure of merit," and on these lines it seems at first glance that it would be feasible to apply such a means of evaluation to cast iron by plotting graphs of transverse, tensile and hardness results. This procedure, while being most useful for research, can hardly be applied to routine testing, and on further examining the properties separately it is very difficult to trace any definite relationship between them as revealed by different tests. Certainly one can within limits approximate the tensile strength of cast iron from its breaking load under a transverse stress; such approximations are nevertheless uncertain, and practice often shows that the expectation is not realised or it may be greatly exceeded.

Again, the tests themselves have to be analysed in their relation to stresses upon the material in service, for direct tension stresses are unusual in practice, while in the majority of castings compression and bending or combinations of these are much more general.

Test-Bars and Test Pieces Representative of Castings.

It was formerly held that no test could be regarded as adequately representing a casting when the test piece was not cast on and thus made a part of the casting and, presumably, made under precisely the same conditions in regard to composition and temperature of casting. The fact that this view is no longer pressed with such insistence is explained by a number of obstacles to the procedure which are upheld by experience. Among these are:—(1) The fact that on certain castings a test-bar cannot possibly be added or included in the cast; (2) that in many cases were the test piece included, it could not have the same thermal history as the body of the casting; and (3) that in many cases the attachment of a test-bar or test piece to the casting would have a damaging effect upon the casting.

There are also further difficulties in regard to ensuring that a separately cast bar shall be similar in all respects to the casting it represents. Again, it must have passed through precisely the same procedure and treatment and be in section as near as possible to that of the casting. The separate casting of the test units is more generally practicable and more commonly relied upon. It is of greatest service when it forms the valuation of castings manufactured on mass-production lines, as regularity of results from tests on successive casts should be a satisfactory guarantee of the strength and quality of the material in the castings themselves. The best and most reliable method of obtaining tests is to cut up a casting and make the test bars from it, and it is here that the tensile test comes in most useful, as a bar of about 6 in. by $1\frac{1}{4}$ in. can often be cut from the wall of a casting and machined into a test piece of 5 sq. in. in area with an acting length of 2 in., or if the section does not permit that dimension, 0.25 sq. in. area may be obtained and quite a fair test for tensile strength carried out.

Seeing that the shortest transverse bar which can fairly be tested is 14 in. long so as to be tested on a 12-in. span, it is generally out of the question to consider the casting-on of such a test unit as an attachment of the casting, and it is certainly quite impossible to cast-on a bar which can be broken on a span of 36 in.

Even with the short test-piece which is required for a tensile test great judgment must be used in arranging that both test bar and casting are not thereby impaired, and in general the founder should be supported in demanding that the test bars be cast alongside but not attached to the casting.

The Transverse Test.

Seeing the general application of this test as an elementary means of valuation, it is desirable to note how its results may be so observed as to obtain the utmost information from it. A transverse test taken without the means of ascertaining the deflection on the bar is not of great service, and may prove very misleading. Nearly all transverse testing machines are equipped with a device for noting this factor, but when a test has to be taken in the type of machine used for tensile it is sometimes necessary to add a fitment to enable this measurement to be taken.

Besides registering the total deflection up to the point of fracture, the rate of deflection relative to the load should be noted, as this furnishes a good index of the regularity of constitution and property of the metal, as will be seen from any graphs of transverse load in cwts. plotted against the deflection in inches.

The B.E.S.A. require a 2 × 1-in. bar on 36-in. span to give 30 cwts. with a deflection of 0.375 in.—by no means extravagant figures. With strong or high duty irons 45 cwts. and upwards with each deflection of 0.45 to 0.50 in. are attained, and certain tough irons of about 37 to 40 cwts. transverse breaking give a deflection of well over 0.50 in. Such irons are usually rather high total carbon irons and give a tensile strength in the neighbourhood of 15 tons per sq. in. Graphs plotted of these irons show very interesting and regularly related load and deflection.

The Tensile Test.

This test is perhaps the most criticised in its application to cast iron; it is, however, frequently demanded in specifications, and being easily

carried out by almost any testing machine, is next to the transverse test the most favoured means of judging the general strength of the material.

It has in the past been noted that widely different results have been obtained for the same classes of iron by different operators and machines, and as the results are so often lower than is expected, the element of uncertainty has led many engineers to condemn it as unsatisfactory or valueless.

The writer is convinced that a great deal of controversy on the question is misdirected, the material often being blamed for defects in reality due to the method of handling the test.

Perhaps the feature of greatest effect is the method of gripping the test piece in the machine together with the control of the applied load, which especially at the outset must be both gradually and carefully applied so that the aligning mechanism can come smoothly into action.

It is found that in test pieces with a parallel acting length fracture most frequently occurs at or near the radiused shoulder. This is due to the following reasons:—(1) Imperfect alignment; (2) faults in machining; (3) friction at grips, and (4) the granular and inelastic nature of the metal. None of these causes can be entirely eliminated, but the first three must be minimised by special care in preparing the test piece and in mounting in the testing machine. The nature of the metal and the inherent weakness in a metal of crystalline structure cannot be ruled out, for in applying tension stress to a bar of varied section the larger section will maintain the load while the smaller is being distorted, and one of the effects of this is to locate the fracture at the point where the section is changing in diameter. This may, of course, be upset where a slight local weakness exists at any other portion of the acting length. The design of the test piece is usually such as to localise as far as possible the point of fracture to the centre of the specimen.

The objection of this is found when it is desired to note the elongation of the material under tension, and where irons for which special properties are claimed come under examination this becomes necessary. It is then essential to have in the test piece a parallel of reasonable length to enable dots for measurements of the extension to be taken, and it is further necessary to have the length of the test piece 0.5 in. in sectional area increased if possible to 4 in., which, however, makes the test specimen more delicate and susceptible to subsidiary loads and stresses.

The value of the tensile test when proper precautions are taken to secure a true result is, in the writer's judgment, undoubted, especially when its results are considered and compared with those of other tests, such as the transverse and Brinell hardness.

Fatigue Tests and Values.

In the transverse and tensile tests applied to cast iron and, for that matter, to any material, the test, though being an application of force, is a static one, the load being gradually applied to the bar under regulated conditions. Such conditions do not always prevail in service for the loads upon the member may be applied, and, removed suddenly, the part may be subjected to multiple strains in various directions which no static test can imitate or measure. Vibratory effects, shocks, sudden blows, etc., may have effects which the knowledge of the material gained through the conventional channels will not adequately provide against have to be considered, and it is therefore of the utmost value to supplement these static tests by certain dynamic ones.

While it is admitted that there is little need of such testing when a casting is made of ample proportions and is only a weight-bearing member, it must be conceded that the growing claims of cast iron to sustain high loads, to exhibit a degree of tenacity and shock resistance qualifying it as a special material for high duty, require safeguards as to its behaviour under the more severe conditions; further, as an important aid to research into its properties, a measure of its endurance under fatigue becomes indispensable.

Fatigue testing is in its infancy, but there are already many appliances for assessing the effects of repeated and sustained blows or impact.

In consideration of the impact effects upon cast iron it is necessary to observe its structural peculiarities. The strength of any crystalline material has been recently shown by Carpenter, Edwards and others to depend principally upon the strength of its individual crystals, though it can also gain a measure of strength from the cohesion existing between its crystals, but as a proportion of the intercrystalline medium of cast iron is graphite, which is to all intents a strengthless material—merely acting as a separator—it is obvious that resistance to sudden blows will not be an outstanding feature of such a metal. All modern means of strengthening and physically improving cast iron have, when successful, resulted in extremely finely divided conditions of graphite and its equal distribution throughout the mass of metal. Its resistance to shock really then becomes a measure of the fineness of grain and dissemination of its graphite.

Types of Impact Testing.

Impact testing is divisible into two classes. Direct single impact as effected by the Izod machine and repeated impact as carried out by the Stanton, Eden-Foster and Bauart-Krupp machines.

The first stage in impact or shock tests is seen in drop testing, and variety of such tests have been in vogue on workshop lines sufficient to measure within limits the capacity of cast iron in various forms to withstand a number of blows or the fall of a weight from various heights. While this type of test furnishes very useful means of test comparisone, it does not form a standard valuation whereby a certain material may be definitely compared with others or given varieties of the same class of materials accurately related. Through other stages the registering impact machine was finally evolved, and the Izod is the best known type of these.

The impact machine, like other testing devices, was the outcome of the necessity for obtaining definite means of determining the qualities of steel, and of assessing and comparing the values of steel of special and alloy varieties, and especially of these metals under different phases of heat treatment.

It will therefore be obvious that its application to cast iron is limited, and the impact machine as arranged for steel testing is not of much service; the usual specimen under test is only 10 × 10 mm. in dimension, and such small sections of cast iron are, of course, quite out of the question; larger sections may, however, be used and within limitations give information of some value, though investigations are still proceeding to ascertain how best this type of test can be applied to cast iron.

In view of the great advance in property and strength of recently evolved special irons, this type of test will undoubtedly become of great value.

Hardness Testing.

This very important property of metals becomes specially so in connection with cast iron, constituting as it does its chief index of utility in regard to machinability, brittleness and endurance. Its measurement does, however, present many difficulties even in the light of modern methods and appliances which furnish such ready and accurate means of assessing this property.

The difficulties are largely those of locality, and for this reason hardness is best expressed by average and limits high and low.

The method of Brinell is beyond question the most applicable to cast iron, apart from the fact that it is already practically the universal standard method, its suitability to cast iron is to be found in that it deals with an area of reasonable dimension, one that in all the better class irons rules out, if reasonable precautions are taken, possibilities of testing only segregated areas or local hard spots. It is essential to use a 10-mm. ball to take where possible a number of readings and to note with each reading the position in regard to outer edge and centre or proximity of chill areas. A load of 3,000 kgs. held for 10 secs. forms a very satisfactory test.

Results of the Brinell tests are of great service in estimating the strength, both tensile and compression, of iron and form a valuable guide to the machining qualities of the material, a factor of no

small importance, as most foundrymen frequently hear from the machine shops when deep cuts are not easily made or high speeds made difficult.

Shear.

Various workers have investigated the shearing properties and strength of cast iron. Platt and Hayward, in some early work, came to the conclusion that the shearing strength of cast iron was in the neighbourhood of 5 tons per sq. in. Izod, however, in later dealing with this property in cast iron, obtained much higher figures, which have been confirmed by Goodman. Both these authorities find the ultimate shear stress of cast iron to vary in different grades between 13 and 17 tons, and show that it followed the tensile strength in the ratio of 1.1 to 1.2, with an occasional exception which was higher than this.

It can hardly be said that the shearing properties of cast iron are frequently tested, and it is interesting to note that in general the shearing strength in tons per sq. in. bears a ratio of tensile to shear of 1:1.2.

The shearing test has recently been investigated by Sipp and Rudeloff, who conclude that valuable indications of the physical properties of cast iron are obtainable from its behaviour under shear, the results of which may be related to both tensile and compression strength.

In regard to the properties of cast iron under shearing strain, an element of uncertainty seems to exist as to whether it is possible to consider shearing quality of elastic or plastic materials side by side with those which are inelastic and non-ductile. It is, the writer believes, a debatable question whether the shear test is an absolute one or an empirical one, in view of the necessarily small test piece employed. Again, the variation in the section and the uncertainty of its vagaries due to thermal sensitivity all contribute to widely differing results, though this applies in a measure to transverse, tensile and other values.

It is nevertheless more than probable that shearing tests will have a more distinct value in their application to special and high duty irons.

Conclusion.

In dealing with the application of accepted principles of testing to cast iron, the author has refrained as far as possible from taking side-tracks leading in directions which involve composition, constitution and other factors which comprise the metallurgical study of cast iron. An effort has been made to look beneath the test facts and figures with a view to getting closer and more exact values and to ensure results being reliable and serviceable.

Out of the following tests two at least should be carried out in duplicate and their results co-related or studied together to note if there is any marked discrepancy between transverse results and expected tensile figures, or hardness and machining quality. Special requirements in an iron or casting, such as toughness, wearing surface, shock resistance, etc., all merit special regard to test results in this connection.

The value of each test standing alone has its limits, and it will be noted that the maximum knowledge regarding the mechanical quality and physical values of iron can only be obtained by a whole series of duplicated tests studied in relation to composition and constitution; thus in research upon cast iron it is indispensable to employ all known means to try out the material and compare it with others having similar or competitive claims.

It may safely be regarded as established that the transverse test upon cast iron is the most universally applied and understood test. Whether it be carried out according to British practice, American or Continental mode, and with British or metric system, its results can, with a little trouble, be brought into line; likewise the tensile test, though this as a single test is open to greater objection.

Brinell hardness is now universally recognised and has a considerable value through its close parallel to the machining properties and toughness of the iron.

Sclerescope hardness, as introduced by Shore, though of great scope and service in metals generally, is not an ideal method for hardness in cast iron owing to the extreme localisation of the test, the same objection being existent when the Brinell test is applied with a small diameter ball of 2 mm.

A great variety of tests of empirical order have useful place in examination of material; many of these are workshop tests having a direct and special relation to the job to be done by the material, their province is local and not universal, whereas mechanical testing in its technical acceptance formulates an absolute value enabling us to tabulate and compare the properties of any or all material.

The problems in connection with production, application and treatment of cast iron are very numerous and complex, but it is beginning to emerge from the unknown and unknowable, and the author is confident that the efforts of all those who contribute to the unravelling of its devious ways and obscure behaviour are already rewarded in the evidences of aroused interest, the extended application and more precise methods of manufacture which is now found associated with it.

Continental Steel Trust.

The managers of the Continental Steel Trust, at their recent meeting in Luxemburg, had decided that statistical information should be collected, showing the inland sales and exports of each of the groups forming the Trust, so that data might be available for consideration at the meeting to be held in Düsseldorf to-day (March 4). The object of the information thus collected is to serve as a basis for fixing allotments in the suggested sale syndicates for semi-finished material, bars, shapes, etc. At this meeting representatives of the French and Belgian works will, it is said, propose a reduction of 2,500,000 tons in the total production of the Trust to apply *pro rata* to the second quarter of the current year. Representatives of the Polish works are said to have accepted an invitation to be present at this meeting.

The journey of Messrs. Vögler and Thyssen to Italy has produced various rumours. Apparently the Italians feel that they have been neglected in the matter of the Steel Trust, but their country is essentially one of imports, and for this reason she has not hitherto been invited to join the Trust. Another version is that the two German industrialists intended to resume the negotiations which had proved fruitless some months ago in regard to the conclusion of a fuel supply agreement. Some millions of tons were involved, and an organisation of large consumers was proposed to be formed for the purpose. The further consideration of the matter was entrusted to a committee. Mussolini is said to be in favour of Italy joining the Trust.

Concerning the financial fund of the Trust, of which comprehensive details were given in our last issue, it is now stated that, including the $1 per ton of production and the penalties imposed for exceeding the allotted output, Germany wil have paid into the fund for the first quarter a total of $6,040,000, and will be refunded $8,540,000, according to the 43 per cent. quota. Belgium will receive $1,250,000 more than she paid in, France $1,253,000 more, and Luxemburg will gain $295,000.

The Socialist members of the Luxemburg Chamber of Representatives have been urging the Government of the Grand Duchy to proceed against the works belonging to the Trust, on the ground that its aim is directed against Labour, but M. Dupong, the Minister of Finance, spoke up in defence of the Trust, and did not feel to be called upon to move in the matter until proofs were forthcoming of the abuse of the Trust's powers.

Personal.

Mr. G. Hedley, of the Linthorpe-Dinsdale Smelting Company, Limited, has been elected president and Mr. B. Walmesley, of Bolckow, Vaughan & Company, Limited, has been elected vice-president of the Cleveland Ironmasters' Association.

Consequent on the appointment of Sir Andrew Duncan, vice-president of the Shipbuilding Employers' Federation, as chairman of the Central Electricity Board, and the decision of Sir Charles Sanders—the present secretary—to retire shortly, the headquarters staff of that Federation has been reorganised and the following appointments have been made:—Secretary, Mr. John S. Boyd; deputy secretary, Mr. Alexander Belch. Mr. Thomas Biggart, who has been intimately connected with the Federation from its inception, and is consultant to the Central Board of the Federation, has been elected an honorary vice-president of the Federation.

XUM

Institute of British Foundrymen.

Annual Meeting of the East Midlands Branch.

At the annual meeting held at the College, Loughborough, Mr. E. Stevenson (Nottingham) presided over a large attendance of members.

The balance-sheet and auditors' report having been accepted, the SECRETARY (Mr. H. Bunting), in his report, stated that the Branch had held seven meetings, including a joint meeting with Sheffield, the average attendance of members showing an increase over the previous year, and in addition six Council meetings had been held, which were well attended. Five new members had been accepted during the year. On the financial side the Branch still kept in a healthy condition, the subscription income during the year under review being the highest in the annals of the Branch.

The election of officers was as follows: President, Mr. H. Pemberton; Senior Vice-President, Mr. J. Lucas; Junior Vice-President, Mr. T. Goodwin; Auditors, Mr. H. J. S. Hilton and Mr. W. F. Smith; Representatives to General Council, Mr. T. Spiers and Mr. B. Vaughan; and Secretary, Mr. H. Bunting.

Short Paper Competition.

Four Papers were submitted, and by ballot the members decided that "The Melting of Cast Iron in the Cupola," by Mr. J. C. Hallamore, Derby, was the winning effort.

"The Melting of Cast Iron in the Cupola."

What is economical melting of cast iron? Surely this is a question every foundryman should ask himself, and perhaps find it rather difficult to give a definite answer.

Taking into consideration all the many different mixes of iron used and melted, and types of cupolas used, difficulties arise which prevent one from arriving at (1) definite standardisation for melting, and (2) a good basis for discussion.

With these views in mind the author presents the following details of a melt, using an 18-in. dia. cupola, with the idea of laying the foundations for a discussion on the question asked at the commencement of this Paper. The period taken, starting from the lighting of the fire to the end of the melt:—

Fire lit	12.30 p.m.
Cupola charged	4.15 ,,

Charges weighing 3 cwt.

Blast on	4.30 ,,
Metal dropping at tuyeres ...	4.40 ,,
First tap	4.50 ,,

about 1 cwt. metal obtained—iron dull and not suitable for casting into moulds.

Second tap ... ... 4.54 p.m.

about 1½ cwt. metal from this tap, fairly hot and suitable for casting.

Third tap ... ... 4.57 p.m.

2½ cwt. metal tapped, good clean hot iron suitable for any thin casting obtained. Then followed taps at average intervals of 3½ minutes:—

Slag hole opened	5.40 p.m.

Three lots of slag run off.

Slag hole closed	5.57 ,,
Last lot of metal tapped ...	6.19 ,,
Total number of taps...	23

	Cwts.	qrs.	lbs.
Weight of pig charged ...	3	2	13
Weight of shop scrap charged	31	2	7
Weight of machine scrap charged	1	1	20
Total weight of iron charged	36	2	12
Weight of coke charged (including bed)	9	1	9
Weight of coke returns after melt	1	0	8
Weight of coke used for melting	8	1	1

From the above figures the following ratio is obtained:—

1 lb. coke melts 4.32 lbs. iron.
1 cwt. coke melts 4 cwt. 1 qr. 8 lbs. iron.

	Cwts.	qrs.	lbs.
Weight of castings sold ...	26	3	27
Weight of runners, etc. ...	6	3	19

Unfortunately the data for this Paper was obtained during the recent strike, and the coke used was of inferior quality. The results given, which are very low compared to other melts, go to show what odds the foundryman was up against during the strike, when he had to use inferior materials. Figures taken from recent melts with superior coke give 1 lb. coke to 5.78 iron, the best result obtained being 1 lb. coke to 6.9 lbs. iron. Other details, such as blast pressure, arrangement of tuyeres, and tuyere ratio all have to be taken into consideration, as all influence the final result.

Discussion.

MR. SPIERS could not see why the fire should be lit at 12.30 p.m. and the cupola not charged until 4.15 p.m. This would occasion a serious coke loss. The author had stated ten minutes elapsed between putting the blast on, and metal dropping at tuyere, and another ten minutes before the first tap. He (Mr. Spiers) thought both of these periods should be reduced to five minutes each. Then with regard to the amount of shop scrap; was the high percentage of scrap used caused through a shortage of pig-iron, or was it due to the inferior quality of casting being required? The ratio of loss between metal put in the cupola and metal received was high, somewhere round about 6 cwt.

MR. BUNTING could not understand why there should be 1½ cwt. to pour down, as not being suitable for anything. He would like the author to indicate the blast pressure, and the tuyere area.

MR. STEVENSON said he had had an 18 in. cupola at work for over six years. The working of an 18 in. cupola was a ten times more difficult proposition than a larger one, for the simple reason that the charges must be accurate. The bed for a start must be a good height above the cupola, and every charge must be weighed to within a few lbs. The charge for this cupola is 300 lbs., the charge for coke is 30 lbs. Now, consider that there is 30 or 40 lbs. of coke in the melting zone. Thus 30 lbs. of coke are added to replace the first lot burned away. The man puts on more fuel; there may be 26 lbs. or 30 lbs. If 26 lbs., then there is 4 lbs. short, which means 40 lbs. less iron would be melted. It would be a very clever man who could accurately gauge 300 lbs. (without weighing), and possibly instead of 300 lbs. there would be 340 lbs. The coke to melt with would be short weight, and if 340 lbs. were put on, then another 40 lbs. short, so that eventually there would be raw iron and scrap at the tuyeres without melting. The first tap from his own cupola was fit for anything that had not to be machined, through the simple reason that an ample coke bed was assured, and the cupola lighted early. His advice to the author, after his own personal experience with an 18 in. cupola, was that he should be able to melt at three minutes, and tap at five minutes. His biggest blow had been 63 cwts., and this was down in three hours.

MR. LUCAS congratulated the youthful author on his Paper, and the straightforward way in which he had placed details of the melting data before them, and considered that when all was taken into account he had not done so very badly after all, as whilst using inferior coke he had obtained a ratio of 1 to 4. It seemed to him that the cupola the author referred to must be a very old one, and it would not be fair to compare the results obtained with a new one, but even as it stood the cupola was melting at the rate of one ton per hour. The author might charge his iron earlier, *i.e.*, let it rest in the furnace a little longer before putting the blast on, and reduce the number of tappings; because for 12 charges 23 tappings were out of balance.

Author's Reply.

The lengthy elapse of time between lighting and charging was explained by the fact that on many occasions, when ready for casting, it was found that the fire had not burned up, and on other occasions jobs came in at the last minute. The coke bed was approximately 5 cwt., which brought it up to 2 ft. above the tuyeres. The coke used in between the charges was 35 lbs. The tuyere hole was approximately 4 in. × 4 in., and the cupola had four tuyeres. The scrap used was mostly shop returns, and odd scrap lying about the works.

MR. STEVENSON proposed, and MR. LUCAS seconded, a vote of thanks to the author.

A Foundry Costing System.

By A. W. G. Bagshawe.

(*Continued from page* 192.)

For convenience in booking, the author uses a long sheet (Fig. 9) with a considerable number of columns. There is, however, no objection to using a separate sheet for each department. It is advisable to total up at the end of each month and transfer the monthly totals to an exactly similar sheet. If these totals are not kept reasonably up to date there is an enormous lot of work at the end of the year. In addition, by totalling up each month, a good deal of useful information can be obtained.

From the moulders' daily cards there is already a record of the amount of good castings produced by each man per day, and consequently by the shop per day. If this total is taken at the end of the month it can be compared with the total wages for moulding, and an average price per cwt. or ton can be found very quickly.

VARIABLE COST — WAGES SUMMARY

Date 1926	Moulding £	s	d	Cores £	s	d	Patterns £	s	d	Fettling £	s	d	Grindir £	s
Jan 1	51	1	6	6	2	3	2	11	0	4	12	9	10	1
2	24	3	8½	3	12	4	1	6	7	4	18	3	4	1
4	52	15	3	6	6	10	2	14	3	4	16	9	10	3
5	49	10	5	6	15	0	2	3	9	4	9	7	10	0
6	48	1	6½	6	7	2	1	15	0	3	12	8	9	
7	48	12	9	6	10	5½	1	16	8	4	10	10	10	7
8	53	6	2	6	17	3	1	5	0	4	8	9	5	1
9	22	1	4	3	0	2	1	7	0	2	6	4	10	11
11	50	11	0	6	16	2	2	14	6	4	11	3	11	18
12	53	10	2½	5	8	0	2	12	0	4	17	5	9	4
13	51	2	1	5	12	1½	2	7	0	3	16	1	9	16
14	49	12	10	5	14	7	2	0	5	3	18	0	10	3
15	48	14	3	5	11	3	1	18	9	4	14	2	9	19
16	26	4	6	2	18	2	2	9	2	2	8	7	10	10
18	49	3	4	5	16	5	1	12	5	4	9	8	10	11
19	50	1	6	6	4	8	2	10	11	4	12	6½	9	2
20	52	8	9	6	11	9	2	12	5	4	3	9	9	12
21	51	12	0	6	12	3	2	14	0	4	11	10	9	19
22	48	3	8½	6	2	0	2	17	1	4	16	3½	5	1
23	23	18	8½	3	5	4	1	11	0	2	10	2	10	12
25	49	0	11	6	9	9	2	9	2	4	8	1	10	8
26	48	15	9	6	12	8	2	12	5	4	13	11	10	11
27	47	10	7	6	16	0	2	13	7	3	18	2	10	4
28	51	2	8	6	18	1	2	15	8	4	15	6	10	6
29	52	1	0	6	10	6	2	8	0	4	14	8	10	6
30	25	3	3½	3	6	8	1	6	6	2	8	4	4	1
Total	1178	9	9	148	18	2	57	4	3	108	4	4	239	11

Fig. 9.—Sheet used for Entering Costs. It is Torn off at the Right Hand.

Organisation Expenses.

This group is rather more troublesome. Under organisation expenses are included all those expenses in a foundry which remain more or less stationary irrespective of fluctuations in output. These are expenses which cannot be changed without altering the organisation. A typical case is fire insurance. If the foundry and its sub-departments is insured for a certain amount the premium will be exactly the same irrespective of the output. It may be decided to spend a certain amount of money on advertising, and contracts are possibly made with trade papers. If the output drops or rises the expenditure will be the same. It is probable that the foreman and charge hands and a certain number of workmen will receive a fixed weekly wage which will not vary. In many of these cases, no matter how good the organisation, the same number of men will deal with considerable increases in tonnage as readily as they will manage to find enough work to keep them occupied if the tonnage decreases.

In this particular group the theory of a yearly average is specially obvious. It is always possible by taking the totals of the various cost accounts in this group to find at any particular time the expenditure up to date and compare it with the tonnage. If the cost per ton is considerably higher than it was in previous years, it is then time to look into the organisation question and consider whether these organisation expenses cannot be substantially reduced. The probability is that if this is not done the foundry will eventually come to a bad end.

The system of recording these organisation expenses is comparatively simple. The number of accounts should be large. It is advisable to have a sundries account. If one is not careful one will find that the expenditure in this sundries account is enormous. That is the time to open up some new accounts, even if they are only used to a very small extent, and very intermittently. The author has, for instance, accounts for such items as "repairs to gas and water pipes" under which sometimes no entry is made for six or twelve

months. On another occasion the expenditure may be considerable. There should be similar accounts for repairs to rumbling barrels, grinding machines, moulding machines, belts in each department, cupolas with their hoists, moulding boxes; in fact, within reason the larger number of accounts the better. It is, in fact, a question of whether it does not pay to keep a separate account for each individual machine. In such a case the totals for one group of machines, such as moulding machines, can be taken at the end of the year, and is sufficient to form a general cost, but the details will

ORGANIZATION EXPENSES — Plant Repairs — 110.

DATE		NAME	DETAILS	£	s	d
1926 Jan	7	Roberts & Co	Gear Wheels For Sand Mill	7	18	6
	29	Thompson Lo	Belt For Blower	2	7	9
	31	A B C Co	Pulley For No 3 Grinding Machine	1	19	7
Feb	8	Smith & Sons	New Arm For Rapid Moulding Machine		12	0
	28	Marshall & Co	Circular Saw Pattern Shop	3	15	0
Mar	12	Bolton Lo	6 Wheels For Barrows	1	16	0
April	2	Northern Elec	2 Sets Carbon Brushes Sand Blast Motor		12	6
	10	Robinson	Rebuilding Core Oven	18	0	0
May	11	Bolton Lo	Replace Truck For Sand	6	10	0
June	1	Northern Elec	New Armature Grinders Motor	18	12	0
	21	Thompson Lo	Belt For Blower	2	7	9
July	17	Thompson Lo	Four New Belts Grinding Machine	3	12	6
Aug	18	General Co	Three Sets Ball Races Pattern Shop	4	15	0
Sept	4	White & Co	New Parts Cupola Weighing Machine	3	2	3
Oct	5	R Jones	Lever For Core Sand Mixer		1	3
Nov	9	Robinson	New Plates Cupola Stage & Filling	8	12	0
Dec	8	Thompson Lo	New Belt For Blower	2	7	9
	18	Grant Crane Co	Re annual Foundry Crane Chains	6	5	0
			Total For Year 1926	93	6	10

FIG. 10.—TYPICAL COST SHEET, SHOWING DESTINATION OF BOUGHT MATERIAL.

COMPLETE COSTS. 1st JAN 1926 TO 31st DEC 1926.

Castings sold. 2256 Tons.

	£	s	d	
Fixed costs per Ton.	8	2	5	
Organisation Costs.	3	7	0	
	11	9	5	Equals 1·23d per lb.
Variable Costs: Moulding. Core making. Pattern making. Fettling. Grinding.	8	16	0	
£	20	5	5	Per Ton.

FIG. 11.—COSTS SUMMARY.

undoubtedly prove which types of machines are most economical from a working point of view as far as repairs are concerned.

A difficult point in this group of "organisation expenses" is the selection of the account to which the various items shall be booked. In nearly every case the information is best obtained from the actual invoices received from the suppliers. If the information is taken from orders issued to suppliers, the quantities delivered and the prices are not always in agreement with the actual amounts ordered. It is, therefore, better to take the figures from the actual invoices. The selection of the cost account under which the various items should be entered is a matter which really can only be satisfactorily dealt with by the works manager or some other competent official who is thoroughly conversant with the whole of the plant and knows what is going on. If these items are dealt with when they are fresh in that man's mind, that is to say, perhaps once a week or even daily, very few mistakes will be made and everything will be booked to the correct place. The same argument applies in the case of wages paid for repairs and similar work.

In the case of foremen, charge hands and general labour in the foundry which cannot be satisfactorily booked to individual orders, records of money spent on wages must be kept on separate cost sheets in this organisation book. This would include such men as inspectors.

It does not seem necessary to show more than one example of a specimen cost sheet (Fig. 10) in this group, as every sheet merely consists of a series of daily or weekly or monthly entries with sufficient detail to explain the expenditure at any later date.

On the summary shown in Fig. 11, the total expenditure is £8 2s. 5d. per ton of castings for a quantity of 2,256 tons. This total is transferred to the final complete cost sheet. The total of the organisation cost is then added on. In this case it has been assumed the amount to be £3 7s., which is, of course, an imaginary one, giving a total of fixed costs and organisation costs of £11 9s. 5d., which is equal to approximately 1.23d. per lb. of castings.

Provided the tonnage remains about 2,250 tons per year, and provided that the prices of the more important raw materials, such as iron and coal, have not varied, this amount of 1.23d. should not vary unless the organisation expenses have been allowed to increase. This can always be checked by comparing the results from month to month.

Date 10th Feb 1927.

ESTIMATE.

NAME. JOHN SMITH & CO. LTD.
VICTORIA STREET.
LONDON S.W.

1100 Castings. Patt. 923 Wt each 4¼ lbs.

	£	s	d
Wt 7650 lbs Basic Rate 1·23d	39	4	1
Moulding 450 Boxes @ 10d	18	15	0
Cores 1,800 @ ¾d each.	6	9	2
3,600 @ 20 for 1d.		15	0
Fettling 7650 lbs @ ·1d lb	3	3	9
Grinding 7650 lbs @ ·15d lb	4	15	8
Pattern Work	2	5	0
Pattern Material		15	0
Total Cost	76	2	8

	s	d
Cost per cwt	22	4
Carriage	1	7
Profit		
Selling Price		

FIG. 12.—ESTIMATING SHEET.

Variable Costs.

Variable costs are assumed in this case to be £8 16s. per ton, making a total of £20 5s. 5d. per ton. That is the average cost of castings over a year, and that is the figure to be taken as the basis for the next year's working and the next year's estimating.

Fig. 12 shows a suggested method of estimating from the figures we have now obtained. The foundry receives an inquiry for 1,800 castings, weighing 4¼ lbs. each. The total weight is 7,650 lbs.—that is, the raw material, representing fixed costs plus organisation expenses at 1.23d. per lb. will amount to £39 4s. 1d. It then remains to estimate for the variable expenses such as moulding four castings in a box, in this case at 10d. a box, cores, fettling, grinding, pattern work and pattern material. The estimating can be either per pound or per box. This gives us the total cost of £76 odd or an average of 22s. 4d. per ton. To this must be added the profit and the selling price. This estimating or quoting price is based on the output of the previous year. It may be quite correctly stated that the cost of raw

material may not be the same. From the pig-iron record the average cost of the iron is known, and the melting loss has been established. If, therefore, iron is costing more, the corresponding amount must be added or deducted if it is costing less. The same thing will apply in the case of coke. With a little care similar calculations can be made for other materials such as sand and ganister.

It is thought that nobody would have any difficulty in obtaining an estimating figure sufficiently accurate for working purposes if the price of raw material in the fixed group varied to any great extent. That figure would make the basis rate per pound 1.23d. higher or lower as the case might

making £6 11s. 3d. and a small item in this particular case of 7s. for pattern metal, which information can be obtained from the stores' issue ticket. This gives us the total cost of the 128 castings which can be turned into a cost of 18s. 11¼d. per cwt. if desirable. From this information it may be seen whether the work has proved profitable or not. This total cost gives valuable information in quoting for repeat quantities, and can also be frequently used with great advantage in estimating for similar work. If a record of this kind is kept one of the largest sources of loss in a foundry can be eliminated, that is, the consistent undertaking of work which does not pay. If one is only making 6d. per cwt. one is

COST RECORD. ORDER NO 10761. A

NAME. John Smith & Sons New St, Birmingham

128. Off Pattern L. 1023.

DATE 1926.	MOULDING.			CORES.			FETTLING.			GRINDING.			PATTERNS.			REMARKS.
June 7th													1	0	6	
" 9th		2	0		3	4								2	3½	Test mould 2/-
" 11th		5	5		5	3										
" 14th		8	9		3	4			6½		1	2				
" 15th		19	2						10½							
" 16th		18	9					1	11		5	9				
" 17th		2	6					1	10½		3	9				
									3							
												6				
TOTAL.	2	16	7		11	11		5	5⅛		11	2	1	2	9½	

£	s.	d.
5	7	11
6	11	3
	7	0
12	6.	2.

REMARKS.	Total Weight Pounds.	Basis Rate per pound.
	1280.	1.23d.

Moulding 5d. each. 142 moulded.
Core 1d. each, 143 made. Pattern Material.
N.B. Loss in Foundry heavy - blow holes.

Cost per cwt exclusive of Patterns } s. d. 18 11¼

TOTAL COST. £

Fig. 13.—Cost Record Sheet.

be, and the author is convinced that half an hour in a month would be all that is required to correct that figure with sufficient accuracy.

On this estimate, the wages which are always liable to variation are actually based on the rates at the time the estimate is made, so that there should be no argument on that point. The question that is left for decision is the amount of profit which should be added.

Finally, there is the individual cost record. That is to say, the actual cost of each individual order. The size of the cost sheet (Fig. 13) depends entirely on the number of departments. The basis cost of 1.23d. per lb. has been established from the previous year's work, subject, of course, to any variation due to increase or fall in the cost of the main items of raw material during the year in question. The dates of the entries are given in the left-hand column and the total wages spent in each department each day should be entered daily from the men's day cards.

Then there is the total of the variable wages spent on the particular order. There is a total weight of 1,280 lbs. at the basis rate 1.23d. per lb., on the safe side, but if one is losing 3d. per cwt. it cannot go on indefinitely.

It would be quite possible to arrange a system of this kind exactly like a set of accountant's books. The cost, however, would be very expensive on the double-entry system. Unless everything balanced perfectly, there would be no point in keeping a double-entry system, but it is questionable whether the cost of making everything balance to a penny at the end of the year would be justified.

As a rough balance to check the system from year to year, the total output from the individual cost sheets and the total expenditure shown on each separate order cost sheet can be taken. The two sets of totals should agree within a reasonably small limit with the total expenditure and output recorded in establishing the average cost for the same year. Thus the general average cost gives the total expenditure of the foundry, consisting of raw materials, labour and other expenses.

The total of the costs of all the individual orders should also give the expenditure for the year. These two should agree. In checking over

in this manner, consideration will have to be given for work partially completed.

To explain the whole system completely it will be necessary to show each individual item and the method of carrying forward the totals in each case. This could not possibly be done in reasonable space.

The author has aimed at putting forward a system of recording expenditure which can be done without a skilled staff of accountants, and which can be done at a reasonable cost. In a small foundry all this work can be easily done in a few hours a day by one man or woman. In a large foundry a number of clerks would be required. So long as the system is carried through daily and accurately there is no troublesome work in any part of the recording. In the end there is, at any rate, the average cost of a ton of castings. One can find out whether any particular customer's work is paying or any section of his work by comparing the costs for various orders with the amount charged.

In addition there is a great deal of extremely valuable detailed information as to where the money is being spent. One can divide up a ton of castings and say that so much goes in pig-iron, so much goes in sand, so much goes in power, and so on.

It is useless going to a foreman of a department and saying that this department is costing too much. It is necessary to be able to point to individual items and draw comparisons with previous years' workings. For instance, the sand-milling plant may be in charge of the foundry foreman. It is useless approaching that foreman and telling him he is using too much sand. It is necessary to be able to say to him that he used a certain quantity of sand per ton of castings during the previous year and he is now using half as much again. If he is a good man he will be able to give the reason, if he is not, one knows where to cut down the expenses.

Hematite as a Base for Chilled Castings?

BY VALLISHE.

During the past few years the subject of metal mixing has been discussed in a much more extensive and serious manner than previously. Most large foundries now possess a metal-mixing and research department of their own. Even the smaller foundries are at present paying considerable attention to this important branch of iron-founding. Maybe the much depressed state of the trade and severe competition is the reason for the advent of such things. Without doubt, bad trade and keen competition compel the producer to bring his plant to the highest degree of efficiency. One cannot stand still in these days.

Now returning to the question of metal mixing, one comes to the case of the jobbing founder. It is here that great difficulty is encountered. In the average jobbing foundry one encountered several different classes of castings, all requiring different grades of metal. Perhaps the quantity required is so small that it is either impossible or unpracticable to make a special blow for each type. Chilled castings, for example, present a difficulty which is at times most perplexing to the general ironfoundry. To turn down the order may mean loss of future trade, a result which cannot be overlooked by any enterprising or far-seeing foundryman. If high-grade chilled castings are to be turned out, a complete study of their composition and manufacture must be made, both from a theoretical and practical standpoint. When experience is practically nil, theory must of course take pride of place.

The question then arises, What base should be adopted for the above class of casting? Many founders make hematite the base, yet the correctness of this method is open to question. It may be a good base for "heat-wear" chilled castings, but perhaps hardly a success for those subject to "friction-wear." Assuming that the former type of casting demands a chill produced by manganese and the latter a chill produced by sulphur, if the above statement is correct, how can we correctly take hematite as a common base for chilled castings? A large sprocket wheel, for example, should have a good depth of chill and the whole metal must be of a close nature, coupled with strength and toughness. To obtain these qualities an iron with low silicon content and very low sulphur content must be used as the base. Maybe at a quick glance one is apt to choose hematite as the likely iron. Any pure, low-silicon (coke-smelted) hematite iron contains too much sulphur to be a real success. Suppose the sulphur content to be 0.13 per cent.—certainly not a high estimate—then in melting this iron, this percentage would increase in the cupola, the result being a casting which is likely to contain blowholes and be lacking in strength. A well-known firm of engineers state that sulphur should not exceed 0.12 per cent. in the casting. Up to this percentage the hardness of the metal is considerably increased without decreasing the strength of the casting. The latter statement does not hold good, however, if the silicon is very low.

On summing up the above statement everything points to the failure of a hematite iron as a suitable base for the aforementioned class of casting. What is really required as an ideal base is a grey iron, low in silicon (say about 0.65 per cent.), and containing but little sulphur. These requirements are all fulfilled in a good pure cold-blast iron which has also a low percentage of phosphorus. It is interesting to know that W. J. Keep, in his book "Cast Iron," quotes the advisability of using charcoal irons for chilling. In taking a pure charcoal iron as a base it is thought advisable to add to it: (1) A quantity of good quality coke-smelted hematite; (2) an iron with a content about 1.5 per cent. phosphorus; (3) ordinary scrap, containing any waster chilled castings if obtainable.

The No. 1 iron tends to prevent the presence of too much phosphorus in the resultant metal. The No. 2 iron gives life and fluidity to the mixture, preventing blow holes and reducing shrinkage. Referring to the third on the list, it will be, of course, understood that this is primarily to cheapen the cost of the mixture. It is, however, somewhat beneficial to include any chilled waster castings that may be obtained, as this improves the qualities of the metal. Sometimes it is really too much trouble for the charge hands to attempt to pick out or separate the chilled iron from the common scrap, and consequently it is most advisable to keep all chilled iron in a stack by itself.

The proportions of the above mixture may vary somewhat, but this can easily be adjusted to one's own liking after a little experimental mixing. An approximate analysis of the above mixture should read: carbon, 3.5; sulphur, 0.07; silicon, 0.93; manganese, 0.8; phosphorus, 0.50. The scrap used should have a sulphur content of about 0.75, and carbon content about 3.25.

Chilled Castings Subjected to "Heat Wear."

Chilled rolls for rolling-mills require a chill produced by manganese. An approximate analysis of a mixture for a chilled roll reads: silicon, 0.84; sulphur, 0.07; manganese, 0.29; phosphorus, 0.55; and carbon content, 3.00 per cent. It will be noticed that the sulphur and phosphorus exist in similar proportions to the mixture for "friction-wear" castings. Although a coke iron may be employed as a base for the above iron, many founders advise a cold blast iron. The writer also came across the following mixture, which has been used with success:—Frodingham white iron, 33.33 per cent.; Grazebrooke cold blast (No. 5), 33.33 per cent; Barrow hematite (No. 4), 16.6 per cent.; Apedale (No. 4), 16.6 per cent.

Returning to the question suggested in the title of this article one finds it rather difficult to give a definite answer, the subject being a very open one. However, it can be safely stated that in the majority of cases, cold-blast iron is more suitable as a base than a hematite iron. No doubt there are several foundrymen who may disagree with the above statement. Maybe they have obtained good results from hematite iron. If so, all well and good, for although theory is quite beneficial in its place, personal experience goes far towards convincing a man.

XUM

Institute of British Foundrymen.

Annual Dinner of the Newcastle Branch.

The annual dinner of the Newcastle Branch was held in the Station Hotel, Newcastle-on-Tyne, on February 12, Mr. E. Wood presiding, and over 100 members and ladies being present. Amongst the guests were the Deputy Lord Mayor of Newcastle, Alderman R. H. Millican, J.P., Mr. E. J. George, Mr. A. T. Thorne, Engnr. Cmdr. C. J. Hawkes, R.N., and Dr. J. A. Smythe, of Armstrong College, and Mr. F. H. Reid, of the Sunderland Technical College.

After the toast of "The King" had been honoured, Mr. V. Stobie proposed the toast of "The Trade and Commerce of Tyneside," coupling with it the name of Alderman Millican. He said that the future had a brighter outlook, but he thought that that was due to the fact that work which should have been done during the seven or eight months of the strike last year was now being carried out. The only way that the trade and commerce of Tyneside could be improved was by obtaining orders, and these orders depended largely on the man in the street. At the present time, however, people were spending as much as they were producing, and, therefore, they had no money left to give orders to the people who needed them.

Alderman Millican, responding, said that he was very glad to be with them that evening. He had begun his business life in an engineering works, the works of Mr. R. W. Hawthorn, as it was then, and when he had found that it was the Foundrymen's dinner which he had to attend that evening, it had taken his mind back to old times. He did not altogether agree with Mr. Stobie, and he thought that it would help them to take an optimistic view of the future. He had 50 years' close association with the Tyne, and had seen many periods of depression followed by periods of success and prosperity. They had all been hard hit by the strike last year, but they would surely all agree with him that times were brighter.

The toast of "Our Guests" was proposed by Mr. J. W. Frier, who, in a short speech, gave them a cordial welcome on behalf of the Branch.

In response, Mr. E. J. George said that he had heard that the right time for propaganda for one's own business was all the time. Therefore, he would remind them that all foundrymen ought to be extremely grateful to his Company, the Consett Iron Company, for keeping them going to a large extent during the seven months' unfortunate stoppage. They had had the distinction of producing during that period rather more than half the total iron produced in Great Britain. They had learnt to do many things during that period; they had learnt to do what they thought was spoiling good iron by doping their furnaces to make "foundry" iron. From their point of view a good iron has a low phosphorus content, whereas foundrymen thought that an iron with a high phosphorus content was better. They had made a very passable imitation of Scotch iron, which had been received with acclamation. It was extremely difficult to look forward, particularly during such a period as they had passed through last year and a few previous years. He was not sure that the Press helped trade by crying out about "booming" trade. He believed in optimism, but reasonable optimism. He was puzzled as to whether the better position was due to developed requirements, accumulated requirements, or increased requirements. He had come to the conclusion that it was the accumulation of requirements from April last year, when there had been signs of increasing prosperity, which had been delayed and made more difficult of realisation through the strike. It was impossible for people to stop work for seven or eight months with no income and all outgo to find themselves in the same position when they resume work; that must all be paid for. The nation had borne tremendous burdens during the war and since. Why should they have to go on bearing them, whilst in America, Germany, Holland, France, Belgium, and even Lorraine there was no unemployment? He still felt that there was something wrong with their methods of dealing with finance and trade, that they should have to continue bearing the burden for so long. His Company was to have the honour of entertaining the Newcastle Branch of the Institute, but, unfortunately, the visit was to be on a Saturday afternoon, when they could not show them everything they would like to. Obviously he would like to show them the processes through from beginning to end, and, if possible, he would get the men to stay and operate on Saturday afternoon. If the men stayed at work on the Saturday afternoon the Institute would have to take it as one of the finest compliments paid to it. He hoped that when they visited the works they would bring the ladies with them and show them all that was to be seen.

The toast of "The Ladies" was proposed by Mr. James Smith, Mrs. J. W. Frier responding.

In proposing the toast of "The Institute of British Foundrymen," Engnr. Cmdr. C. J. Hawkes, R.N., M.Sc., said that he had noticed that the Institute was founded with the object of combining theory and practice, and he thought that good results had been attained through this combination. Many of the foundryman's troubles were due to the fact that the draughtsman did not realise the difficulty of putting into practice an idea which seemed perfectly reasonable on a drawing board. When the metallurgist had been first introduced into the foundry he had not been well received, but now both the foundryman and the metallurgist were beginning to realise the value of the assistance they could give one another. Another point that had struck him was the fact that they made no secret of their difficulties, but discussed them and freely criticised each other's methods. In this country people were waking up to the fact that research was essential, but, unfortunately, many people did not realise that research took time and could not be hurried.

The Chairman, Mr. E. Wood, responded on behalf of Mr. V. C. Faulkner, President of the Institute, who was then attending a dinner in Loughborough. He said that he was glad to hear that some people held optimistic views concerning the trade outlook, and that, so far as he was concerned, he thought that they would have work to keep them busy for at least six months. Referring to the Institute, he said that one of their aims was to get draughtsmen and engineers to join, and to impress upon them the necessity of consulting the moulder before a casting was designed.

Foundry Query.

Pipe Making in the Dominions.

Being an isolated foundry in a far-off Dominion, I would like to know about the placing of the cores in the mould and the methods used for insuring a uniform thickness of section. If I was actually moulding the job myself I would make a roller about an inch wide carrying a diameter equal to the required thickness of the metal, and attach this to a flexible cable of some sort which would combine rigidity with flexibility. The roller could then be moved over every portion of the mould and thus the thin places located. The top box is another matter of difficulty, because we have no satisfactory method of ascertaining what thickness of metal one has. When we have the two halves of the core in position in the mould ready for the top box, clay balls are placed around the upper surface, three on each end and three in the middle. Consequently at these nine spots the balls are crushed down and the thicknesses measured. But where we are in difficulty is at the joint line, where the slope is too great for clay to rest and measuring in this position is impossible. Moreover, after the bottom half of the core has been set in position in the mould the top half of the core is laid on top of this bottom half and more or less centred. But it is very easy to get the top half slightly twisted with respect to the bottom half—particularly at the ends. This overlap can be as much as $\frac{1}{4}$ in. without being noticed, and this constitutes our main trouble. Out of this last ten pipes tested nine were thin to an extent of $\frac{1}{4}$ in. at the position indicated—that is at the joint and at the ends. Any information your readers can give will be appreciated by

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Trade Talk.

GREENWOOD & BATLEY, LIMITED, Leeds, have appointed Haslam & Stretton, Limited, 11, Windsor Place, Cardiff, as their agents for South Wales.

A. C. E. C. (ATELIERS DE CONSTRUCTIONS ELECTRIQUES DE CHARLEROI), 56, Victoria Street, London, S.W.1, have an order from the First Garden City, Limited, Letchworth, for a 1,000 k.w. La Cour motor converter.

IT IS REPORTED that negotiations are in progress for establishing a close working alliance between Vickers, Limited, and Sir W. G. Armstrong, Whitworth & Company, Limited. There has, of course, always been a working arrangement between the two companies ever since they became armament firms. The secretary of Vickers, Limited, states that he knows of no other arrangement being contemplated. Lord Southborough, chairman of Sir W. G. Armstrong, Whitworth & Company, Limited, in the course of an interview, said he knew nothing of the rumour concerning any working alliance with Vickers.

CHRISTMAS & WALTERS, LIMITED, of Caxton House, Westminster, have received a contract from the Park Gate Iron and Steel Company, Limited, for a gas plant to substitute an existing plant for providing steel to open-hearth furnaces. The plant will be capable of gasifying over 12 tons of coal per hour, and will consist of five R. D. Wood gas machines with dust-catching arrangements, gas-regulating apparatus, gas house, coal-wagon tipper, and grab bucket crane for handling coal and ashes. The plant will be of the most up-to-date labour-saving design, and will require the minimum of labour to operate it from the reception of the coal wagons to the departure of the wagons containing the residue.

SIR WILLIAM LARKE, director of the National Federation of Iron and Steel Manufacturers, at a luncheon of the American Chamber of Commerce in London, at the Hotel Cecil, said that as long ago as 1890 America had established supremacy in the quantity production of steel, but the supremacy in quality of British steel that was established in connection with rails had maintained ever since throughout the markets of the world. Britain's competition had come since the war from the Continent, where the collapse of currencies was a material factor, and the home industry suffered. There had emerged an international agreement between Continental producers regarding production, but there was a difficulty about bringing in the British producer on account of variance of the 1926 figures from the normal production, which were still influenced by the exchange question. He thought an international steel agreement was a great step towards the reconstruction of trade. "Our productive efficiency," he added, "is improving from day to day as a result of the co-operation between employers and employed. The industry has never had a stoppage of any magnitude arising out of itself for 50 years, an example that might well be followed in many directions. I believe we are at the close of an old era, and that we are witnessing the commencement of a new era in which we may be tested to the full, but which is full of the promise of a great reward if we in this country will only be true to the traditions of the past."

A JOHANNESBURG REPORT stated that, in connection with the South African Government's Iron and Steel Bill, meetings have taken place between Ministers and representatives of overseas interests, including Mr. W. R. Lysaght, who said, in the course of an interview, that he had come on behalf of his own firm, John Lysaght, Limited, and of Guest, Keen & Nettlefolds, Limited, to obtain detailed information of the Government plans. If it is the intention of the Government to encourage the establishment of subsidiary concerns, Mr. Lysaght said he purposed investigating the possibilities on the spot and ascertaining the terms that the Government is prepared to offer. Other overseas magnates, including Sir W. C. Wright, chairman of Baldwins, and Mr. R. H. Whitelegg, general manager of Beyer, Peacock & Company, have also conferred with the Ministers. Mr. Beyers, Minister of Mines, speaking in defence of the Bill, agreed with General Smuts that there was place for only one big steel works in South Africa, and said that was the policy which the Government had decided upon. He denied that the Bill had been imposed upon the Government by the Labour party section of its supporters, for every member of the Cabinet was interested, and had actively participated in framing the Bill. The Minister of Mines further intimated that the Union Steel Corporation had been warned of what the Government intended to do, and understood the position. He quoted an expert report condemning the establishment of steel works in Natal, and pointed out that the proposition laid before them in this Bill was based upon South Africa's own internal requirements, and had nothing to do with the export trade.

Contracts Open.

Aberaman.—(1) Bar and other iron; (1a) mild steel bars, angles and tees; (2) bolts, nuts, rivets, etc.; (3) gunmetal fittings; (7) steel girders, channels and rails; (8) nails; (10) cast steel, tram wheels, axles, etc.; (11) steam and Williams' joint tubes and fittings; (14) chains; (20) wire ropes, etc.; (23) electric cable and accessories, for six months from April 1, for the Powell Duffryn Steam Coal Company, Limited. The Stores Manager, Aberaman Offices, Aberdare.

Ashford, Kent, March 14.—Two electrically-driven centrifugal pumps, for the Ashford Urban District Council. Mr. H. Wilson, Electricity Works, Ashford.

Bangkok, Siam, May 14.—Axle-boxes, bearing springs and axle guards for goods rolling-stock, B.E. 2470, for the Administration of the Royal State Railways of Siam, Bangkok. Messrs. Sandberg, 40, Grosvenor Gardens, London, S.W.1. (Fee, £1 per set, non-returnable.)

Brecon, March 16.—(1) Generating plant and switchgear; (2) battery of accumulators and connections; (3) underground mains; (4) overhead mains, for the Corporation. Messrs. Arthur Ellis & Partners, 9, Park Place, Cardiff. (Fee £3 3s., returnable; additional copies £1 1s. each, non-returnable.)

Batley, March 23.—Steelwork and ironwork for eight bridges on an aqueduct, for the Corporation. Messrs. G. H. Hill & Sons (Manchester), civil engineers, 40, Kennedy Street, Manchester. (Fee, £2 2s., returnable.)

Edinburgh, March 21.—(a) Underground insulated cables; (b) underground conduits for electricity supply cables; (c) pavement and road box frames and covers; (e) sheet and bar iron; (f) brass and copper castings, etc.; (g) malleable iron tubes and fittings; (k) cast-iron material; (l) electricity supply meters; and (m) meter boards, for 12 months from May 16, for the Town Council. The Engineer and Manager's Office, Dewar Place, Edinburgh.

Great Yarmouth, March 18.—(7) Gully grates, manhole covers, and general castings; (8) wrought-iron, steel, etc., for 12 months from April 1, for the Town Council. The Borough Engineer's Office, Great Yarmouth.

Haslingden, March 12.—Iron castings for year ending March 31, 1928, for the Town Council. Mr. R. Taylor, borough surveyor, Haslingden.

Johannesburg, April 7.—(No. 958) Steel and cast-iron bridge work, for the South African Railways and Harbours. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

London, W.2, March 15.—(1) Laminated springs; (2) helical and volute springs; (3) tyres and rolled-steel wheel centres; (4) steel axles and forgings; (5) iron plates and bars; (6) steel plates and sheets; (7) steel bars and blooms; (8) steel castings (wheel centres); (9) steel castings (miscellaneous); (11) chain and iron for chain manufacture; (12) tubes and fittings; (13) cold drawn steel tubes; (14) cast-iron socket, etc., pipes and iron castings; (15) galvanised sheets; (16) tool steel, for the Great Western Railway. The Stores Superintendent, Swindon.

Old Sawley, Derby, March 18.—2,250 yards of 4-in. and 3-in. cast-iron pipes as water mains, etc., for the Shardlow Rural District Council. Messrs. Elliott & Brown, chartered civil engineers, Burton Buildings, Parliament Street, Nottingham. (Fee £2 2s., returnable.)

Tipton, March 25.—(7) Cast-iron gully grates, manhole covers, frames, etc., for the Tipton Urban District Council. The Surveyor, Public Offices, Tipton.

Twickenham, March 12.—232 lineal yards of 4-in. and 3-in. cast-iron water main, with four fire hydrants, for the Corporation. The Borough Engineer and Surveyor, Town Hall, Twickenham. (Fee £1 1s., returnable.)

Obituary.

MR. EDWARD THEWLIS, formerly a well-known Huddersfield engineer, and founder of the firm of Thewlis & Company, Folly Hall, Huddersfield, has died suddenly at Blackpool, where he had been living for several years.

THE DEATH occurred on February 28, at his residence, "Montrose," 51, Woodside Park Road, North Finchley, of Mr. James Pitcairn Halket, aged 83 years, for fifty years managing director of Glengall Iron Works, Limited, Millwall, E.

THE DEATH OCCURRED recently, at his residence, Cromer Villa, Cupar, of Mr. James Eyre Turnbull, ironfounder, manager for James Carrick & Sons, Dalry Road, Edinburgh, of Hillside Foundry Cupar. The deceased gentleman was 64 years of age. He was a native of Galashiels, and spent most of his working life in Edinburgh.

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AIMS AND OBJECTS OF THE ASSOCIATION.

a. The Association was called into being as a precautionary measure for firms engaged in the Foundry and Equipment Supplies Trades against any multiplicity of Foundry Trade Exhibitions being organised throughout the country without reference to the wishes or interests of potential exhibitors; members of the Association have therefore pledged themselves not to take part in any Foundry Exhibition in the United Kingdom not held under the auspices or with the concurrence of the Association.

b. THE ASSOCIATION IS *NOT* A PRICE FIXING RING. There is no intention whatever of attempting to fix or even discuss the prices at which the various commodities marketed by the various members are to be listed.

c. The Association has no intention of taking any part in any labour disputes or negotiations, and IS NOT AN EMPLOYERS' FEDERATION for that purpose.

d. The Association intends to encourage among its members the freest exchange of all kinds of information regarding markets, general and particular, so that members may have the maximum advice available regarding business opportunities and also warnings of possible pitfalls.

e. It is the wish, hope, and intention of the Association that its badge may come to be regarded as the hall-mark of fair trading in the Industry. It is intended to encourage only the highest standard of business practice, so that the world may know that a firm carrying the Association's badge has the Association's guarantee of fair and square dealing.

f. OVERSEAS VISITORS.—The Association is anxious to undertake so far as possible the duties of host to distinguished dominion and overseas visitors whose business in this country comes within its scope. In particular it is proposed where required and advisable:—

1. To make hotel reservations throughout the country.
2. To arrange visits to prominent foundries throughout the country.
3. To give to overseas visitors, through its individual members, club facilities in the chief cities of the Kingdom.
4. In certain cases to arrange hospitality to be given by the Association and to be subscribed for voluntarily by members interested, to the visitor or visitors concerned.

g. To foster a co-operative study of foundry requirements and problems by an interchange of lectures and demonstrations as between members of the Association and foundrymen.

Office of the Association: AVENUE CHAMBERS, SOUTHAMPTON ROW, LONDON, W.C.1
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IRON AND STEEL MARKETS.

Pig-Iron.

MIDDLESBROUGH.—The Cleveland iron trade is in the doldrums just now. There was a big spurt after the coal strike, and there are now eight more blast furnaces at work on the North-East Coast than there were before the coal stoppage. But expansion of production has been brought to a sudden stop. There are nearly 60 blast furnaces still idle in the district, and not one has been lighted up during the past month. That is entirely due to the lack of adequate coke supplies. Were more coke available, it is certain that many of these idle furnaces would be put into commission, but there is scarcely enough fuel to keep the plant now at work in continued activity, and coke prices have ascended to a level which almost eliminates the ironmasters' narrow margin of profit. Worse than that is the fact that these high prices continue to make Continental markets out of reach. There are plenty of inquiries from European buyers, but scarcely one of them has resulted in actual business. The demand is there all right, but Cleveland's prices are too high, and so the foreign markets cannot be recaptured yet awhile. British consumers continue to pursue a policy of hand-to-mouth purchases. Sooner or later, they argue, coke prices, and with them pig-iron prices, must fall. Meanwhile, they are content to buy only for prompt needs, and to defer making forward contracts. Makers, on the other hand, are not worrying. One way or another they are getting rid of all their output, and they certainly do not contemplate cutting prices until costs of production fall.

In regard to hematite, although costs of production tend rather to advance than to fall, competition for orders has become so keen that a certain amount of price-cutting has begun. Middlesbrough makers are now offering mixed numbers at 89s. per ton, and probably 88s. would not be refused for a good order. Indeed, even a price below this latter figure is reported to have been accepted for an unnamed brand. On the North-West Coast makers are receiving a good deal of inquiry from prospective customers, but are just failing to arrange orders. Business is in the state that may be described as "hanging," but there is a hopeful feeling that, sooner or later, and more probably sooner, much of it will materialise. The undertone is certainly good. For instance, quite a useful amount of buying by the Continent is going on. There is nothing new in that, of course; as a matter of fact, the Continental market is one of the best that hematite pig-iron makers have had at their command in the post-war years. Still, it is increasing, and if other markets were exhibiting similar improvement, there would be solid ground for optimism as to the maintenance of production throughout the summer months. The position now is that April is the furthest ahead that users are booking, and that until May the whole of the make of the sixteen furnaces in blast between Workington and Carnforth can be disposed of. Though orders for railway material are thin, there is a good deal of work to be done at the steelworks at Workington and at Barrow, and there, of course, a large part of the output of iron is being absorbed. The shipments oversea are not inconsiderable, and there are heavy deliveries to the Midlands, and parcels are being sent to Scotland and South Wales.

MANCHESTER.—If not quite depressed, the Lancashire markets during the past week could not by any means be described as cheerful, and there is no room for doubt that consumers are still holding off the market for more favourable prices than they are able to get at present. There has been no apparent weakening of quotations for pig-iron since the last report, although there is talk of cut prices being offered here and there. Midland brands—Derbyshire and Staffordshire—are still quoted at 93s. and 92s. 6d. per ton respectively, delivered Manchester or equal distance, whilst Cleveland No. 3 is fully maintained at the equivalent of the delivered price of 95s. 6d., with Scottish makes at round 112s. 6d., and East and West Coast hematites at 97s. and 98s. per ton. Buying in all sections of the pig-iron market, so far as new commitments are concerned, continues on a hand-to-mouth scale, forward contracts at ruling quotations being almost unheard of.

THE MIDLANDS.—Prices of various qualities of foundry iron have undergone no change; the figure generally asked for No. 3 Northants is 80s., with 5s. extra for No. 1, which is very scarce. Derbyshire No. 3 does not obtain a uniform level in price, some makers asking 82s. 6d. and others 85s. per ton. No. 3 North Staffordshire is also quoted at this figure at the furnaces. No heavy bookings are being made, the ironfounders, both small and large, are not prepared at this juncture to enter into the market for forward supplies, and have the opinion that before many weeks have expired lower levels will obtain. Very little No. 3 Cleveland is being purchased locally, as the price of 97s. 6d. per ton delivered is rather too high in comparison with the Midland furnaces' quotations.

Metals.

Copper.—Standard cash copper has experienced a strong upward movement and unusual activity, sales in one week amounting to as much as 14,000 tons. The pressure of buying on one occasion was particularly intense, and chiefly related to odd dates maturing within the next two months, this indicating that the short interest became rather alarmed at the continuous advance. Buying by consumers on both sides of the Atlantic has been active throughout, and the fact that the export combine was not raising its terms unduly or to the same extent as in the speculative medium has undoubtedly encouraged the trade buying movement. Confidence in the stability of the market has become strengthened. The revival had been fully expected for some time, and was only held back by market uncertainty, so that a replenishment of stocks by consumers has been accelerated in order to provide for needs over the spring.

Official closing prices of standard copper have been as follow :—

Cash : Thursday, £56 17s. 6d. to £57 ; Friday, £56 15s. to £56 17s. 6d. ; Monday, £56 2s. 6d. to £56 5s. ; Tuesday, £56 2s. 6d. to £56 5s. ; Wednesday, £55 15s. to £55 17s. 6d.

Three Months : Thursday, £57 7s. 6d. to £57 10s. ; Friday, £57 5s. to £57 7s. 6d. ; Monday, £56 15s. to £56 17s. 6d. ; Tuesday, £56 12s. 6d. to £56 15s. ; Wednesday, £56 6s. 3d. to £56 8s. 9d.

Tin.—The generally anticipated substantial improvement in the statistical position of tin has materialised, and has affected the market accordingly. Stocks landing and afloat in Europe and America amounted to 13,754 tons, as against 14,978 tons in January, showing a decrease in the total visible supply of 1,224 tons. Monthly supplies from all sources amounted to 8,117 tons, as against 8,190 tons for the previous month, deliveries in that period being 9,341 tons, as against 10,029 tons for January. The metal has fluctuated to some extent, but the tone has been good and prices have moved upwards. Forward metal has come more strongly into demand, with the result that the backwardation has narrowed further. America has done a fair business.

Official closing prices of standard tin have been as under :—

Cash : Thursday, £316 5s. to £316 10s. ; Friday, £319 10s. to £319 15s. ; Monday, £317 10s. to £317 15s. ; Tuesday, £313 to £313 10s. ; Wednesday, £315 15s. to £316.

Three Months : Thursday, £301 10s. to £301 15s. ; Friday, £301 15s. to £302 5s. ; Monday, £300 10s. to £300 15s. ; Tuesday, £299 10s. to £299 15s. ; Wednesday, £301 5s. to £301 15s.

Spelter.—In regard to ordinary spelter, discussions have been proceeding recently between the Belgian Vieille Montagne Company and the Liege Mining Company, belonging to the German Mansfield group, on the subject of the proposed establishment of an international zinc syndicate for the purpose of output regulation. Inquiry has revived.

The following are the week's prices :—

Ordinary : Thursday, £31 2s. 6d. ; Friday, £31 2s. 6d. ; Monday, £30 12s. 6d. ; Tuesday, £30 17s. 6d. ; Wednesday, £31.

Lead.—The soft foreign lead position appears to be more promising than for some weeks past, and prices are now back to the level which prevailed early in January. Of late there has been considerable pressure to sell forward, but the heavy offerings are well taken up. Consumption in this country is slowly improving, whilst large quantities are being absorbed on the Continent. Supplies have been fairly liberal, and some accumulation of stocks has been unavoidable, but failing an early improvement in values shipments are likely to be lighter. The reduction in the output is stated to be imperative owing to the disappointing European demand and the low rates ruling for the metal.

The week's prices are appended :—

Soft foreign (prompt) : Thursday, £23 12s. 6d. ; Friday, £23 17s. 6d. ; Monday, £23 12s. 6d. ; Tuesday, £23 5s. ; Wednesday, £23 3s. 9d.